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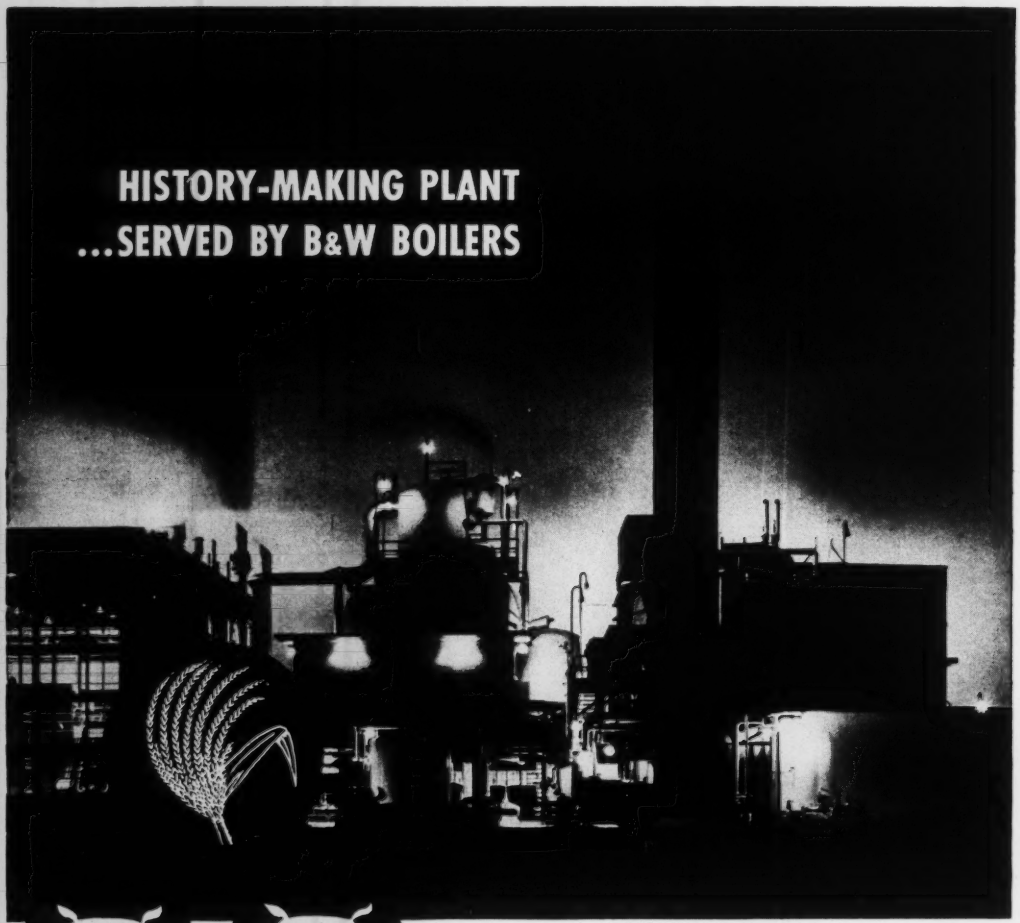
HISTORY-MAKING PLANT ...SERVED BY B&W BOILERS



STARCH AND DEXTROSE FROM MILO MAIZE

Corn Products Refining Company's new Bluebonnet Plant at Corpus Christi, Texas, is revolutionary in many respects. Engineered and built by the H. K. Ferguson Co., it's the only plant ever designed to operate on milo maize and the first new starch-from-grain plant in 27 years. It's the first to employ continuous and fully automatic operation. And it is in the open, with walls and enclosures virtually eliminated.

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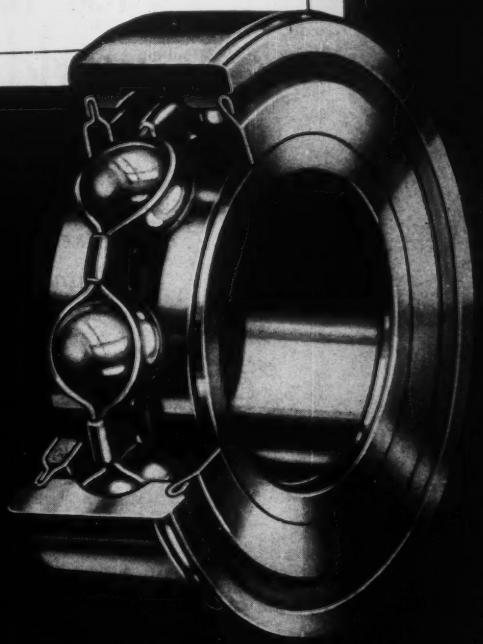

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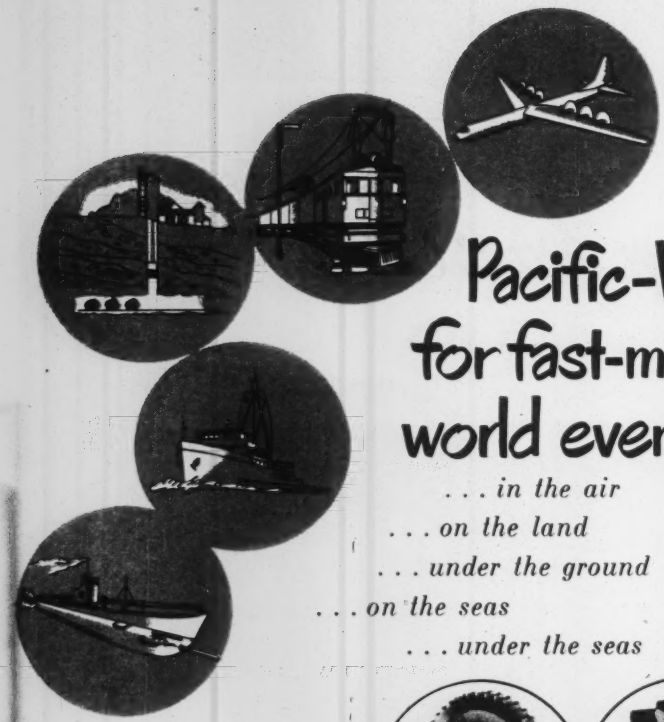

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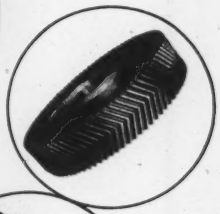

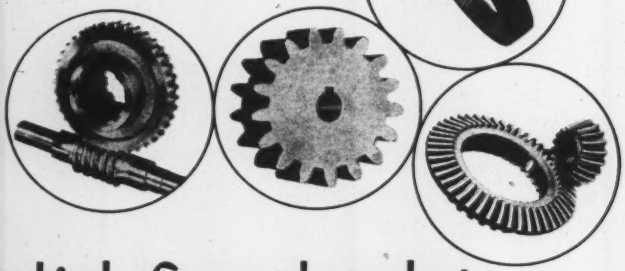

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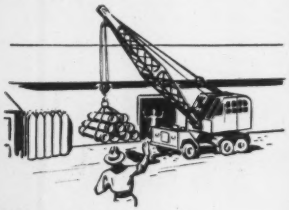

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If you're concerned with power transmission, you'll want to know about our Gyrol Fluid Drives. Developed originally for use with mechanical draft fans, Gyrol Fluid Drives are today widely used in industry. They offer three important advantages—smoother acceleration, overload protection and substantial power savings. One company uses Fluid Drives on a crane that picks up acetylene tanks. Before they were installed, the tanks got such a violent swing from the quick start they would often damage building walls. Since using the Fluid Drives, they've had no trouble.

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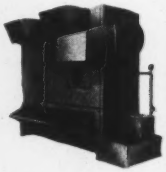

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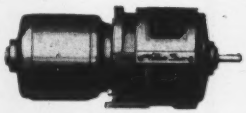
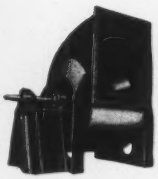


Gyrol Fluid Drives



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FORGINGS vs. CASTINGS?

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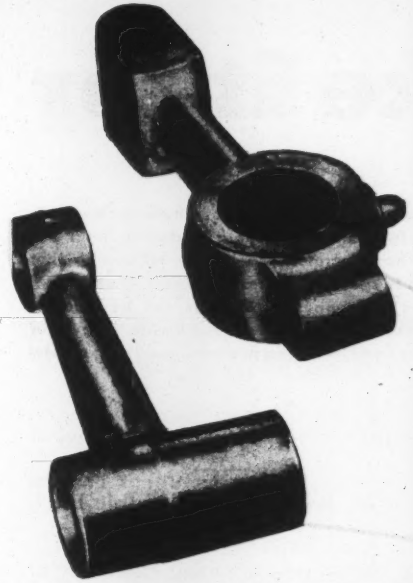

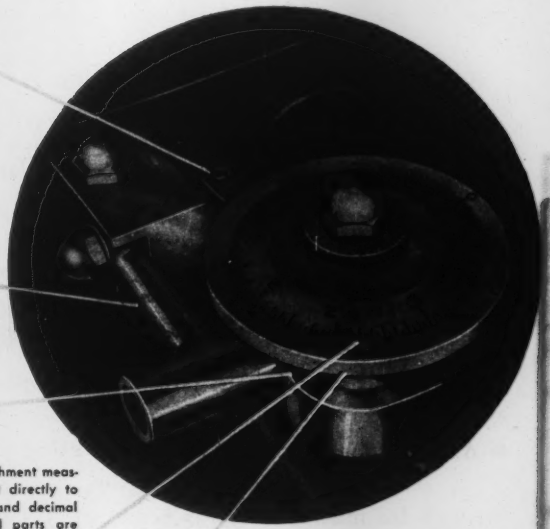

The Weldon Lathe Attachment measures carriage movement directly to .001". Both fractional and decimal dials are available. All parts are chromium plated.

Anaconda Die Pressed Forgings illustrated are full-size and unretouched. On the spindle housing, right, machining costs were reduced 70%; on the dial, next above, 40%.

In the first place, they shouldn't be in the same ring together, because Anaconda Die Pressed Brass Forgings have almost twice the strength of ordinary brass sand castings.

The Weldon Tool Co. of Cleveland, makers of the Weldon Direct Reading Measuring Attachment for lathes, switched from sand castings to forgings and found the extra strength a big sales advantage.

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● A manufacturer had been using a standard roller chain for years on his machine. A Rex Field Sales Engineer showed him that he could use a Baldwin-Rex Double Pitch Roller Chain and get the same operating efficiency at a substantial reduction in cost because speeds did not require standard roller chain.

● Another manufacturer had been using conventional flat top chain to carry cans through his machine. It was necessary to pay a premium for special bevel top plates to avoid tipping of cans. By switching to Rex TableTop® he got even smoother tip-free operation at far lower cost.

● A business machine manufacturer, faced with the need for more accurate timing, consulted his Rex Field Sales Engineer and switched from leather belts to the smallest roller chain—¼-inch pitch Baldwin-Rex No. 25 —and accomplished his objectives.

● In carrying material through a scalder, a manufacturer had been using conventional steel chain. By switching to Rex Cast Pintle Chain, he not only cut his costs but the chain lasted far longer.

granted?

● In another instance, a Rex Field Sales Engineer persuaded a manufacturer to switch from the pin-and-cotter roller chain he was using to a Baldwin-Rex Riveted Roller Chain. The change not only resulted in an initial cost saving but in longer life since the rivets have greater holding power.

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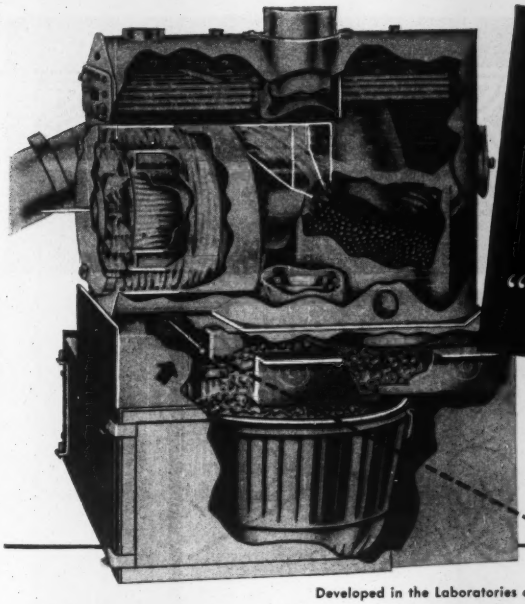

Multi-purpose THERMOSTAT controls furnace operation by "seeing" radiant heat

Arrow points to THERMOSWITCH unit which controls operation of grate in this modern anthracite home heater.

Developed in the Laboratories of the Anthracite Institute

Outstanding among anthracite home heating equipment, the Axeman-Anderson Anthratube stokes itself automatically, burns up to 38% less fuel than ordinary coal furnaces, and captures over 80% of the coal's usable heat. A feature of its efficient operation is a self-shaking grate, and a basic design-problem was to devise a means of actuating this grate at the proper times for ash removal. Since ash is not formed at a constant rate, timing devices were precluded.

Thermostatic control was indicated, but it was found that when any of various standard thermostats were placed in or near the fire they either could not stand the temperature or were too slow in operation.

The solution was a Fenwal THERMOSWITCH unit, placed about six inches in front of the grate bed, where it responds by "seeing" the radiant heat from the fire bed. When ash collects, the THERMOSWITCH control can no longer "see" the fire and, therefore, the shell temperature drops, closing the operating circuits, causing the grate to move forward and back, dumping the ash, until the fire is again "visible" to the control.

The activating element of THERMOSWITCH thermostats is the single-metal shell that expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts. This unique performance has proved to be the logical answer to the widest variety of control problems.

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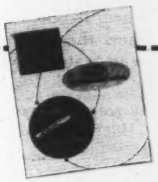

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OTHER (Please fill in your special requirements) .....
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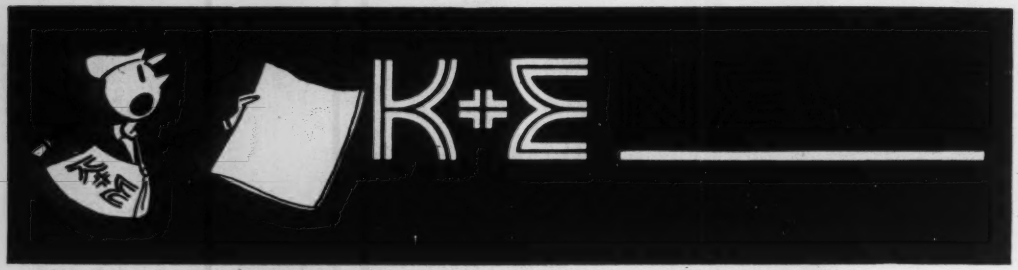
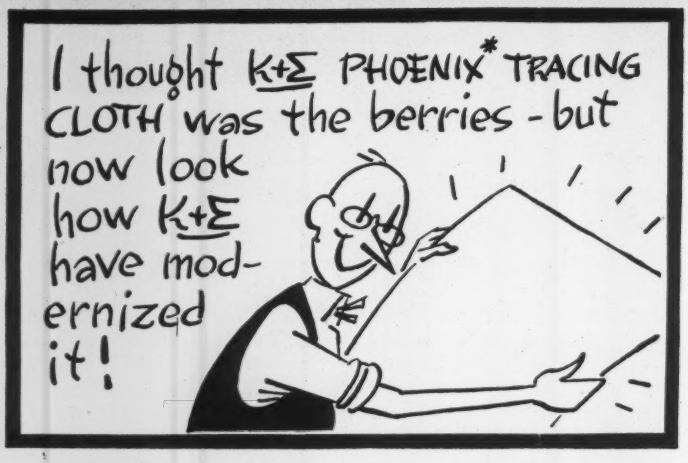




how good can a tracing cloth get!

PHOENIX* Tracing Cloth always did feel good to an engineer's pencil, but, now, new improved N166 PHOENIX feels better than ever—performs better—is better. It's whiter than ever—which gives it better contrast for pencil line drawings. (This helps reprint transparency.)

The new PHOENIX is toughened to take today's new vigorous printing techniques—repeated trips under higher powered lights or through hotter printing machines.

The new N166 thrives under an ultra-violet test, which equals thousands of prints on a machine, or years of exposure to daylight. No appreciable yellowing.

Improved PHOENIX resists heat of glass cylinders even as high as 250° to 275°. Will not stick.

K&E have also given this cloth a Bureau of Standards three day 212° heat test, which is the equivalent of years of aging. It retains its whiteness remarkably well.

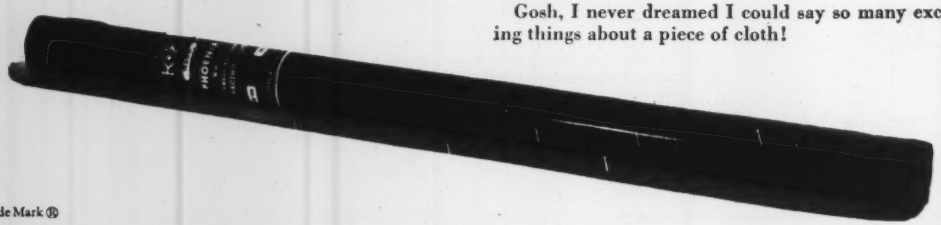
The new PHOENIX resists ammonia vapors and discoloration by contact with diazo prints in storage.

Its surface takes friction heat of motor erasers without softening or stain.

2-way water resistant

Both sides of the new PHOENIX are wonderfully water-resistant. This is important, since, if one side is more water-resistant than the other, the weaker side runs the show. By water, I mean water AND perspiration.

Gosh, I never dreamed I could say so many exciting things about a piece of cloth!

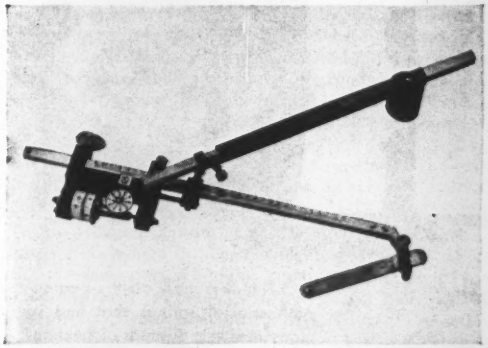


*Trade Mark ®

—and it's loaded with inbuilt K&E precision

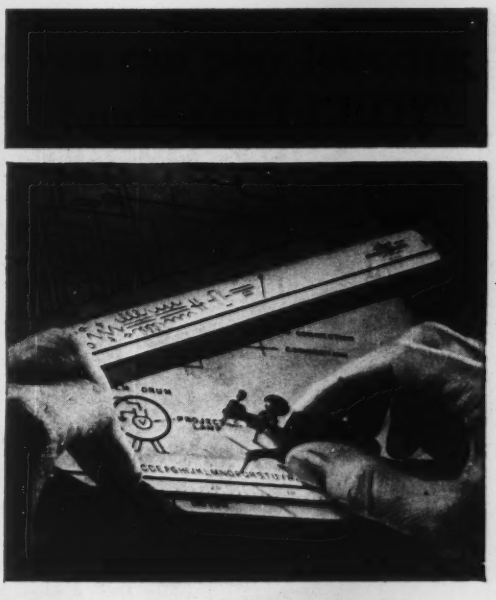
Don't ask me *how* it works. It's Greek to me. But you engineers probably understand that a planimeter will measure the area of an irregular plane if you push a little point accurately around its outline.

Engineers also tell me a planimeter has to be about the most accurate thing on wheels, or it will tell falsehoods. If it has rheumatism in any of its joints, water on the knee, or a crick in its funny bone, watch out.



Engineers tell me that K&E COMPENSATING POLAR PLANIMETERS are built beautifully for long-lasting cat's-whisker precision—that is, unless you go dropping them on the floor or using them to fight mosquitos.

A new K&E Manual comes with each instrument. It includes description of a unique method, which greatly increases the size of the area that can be measured.



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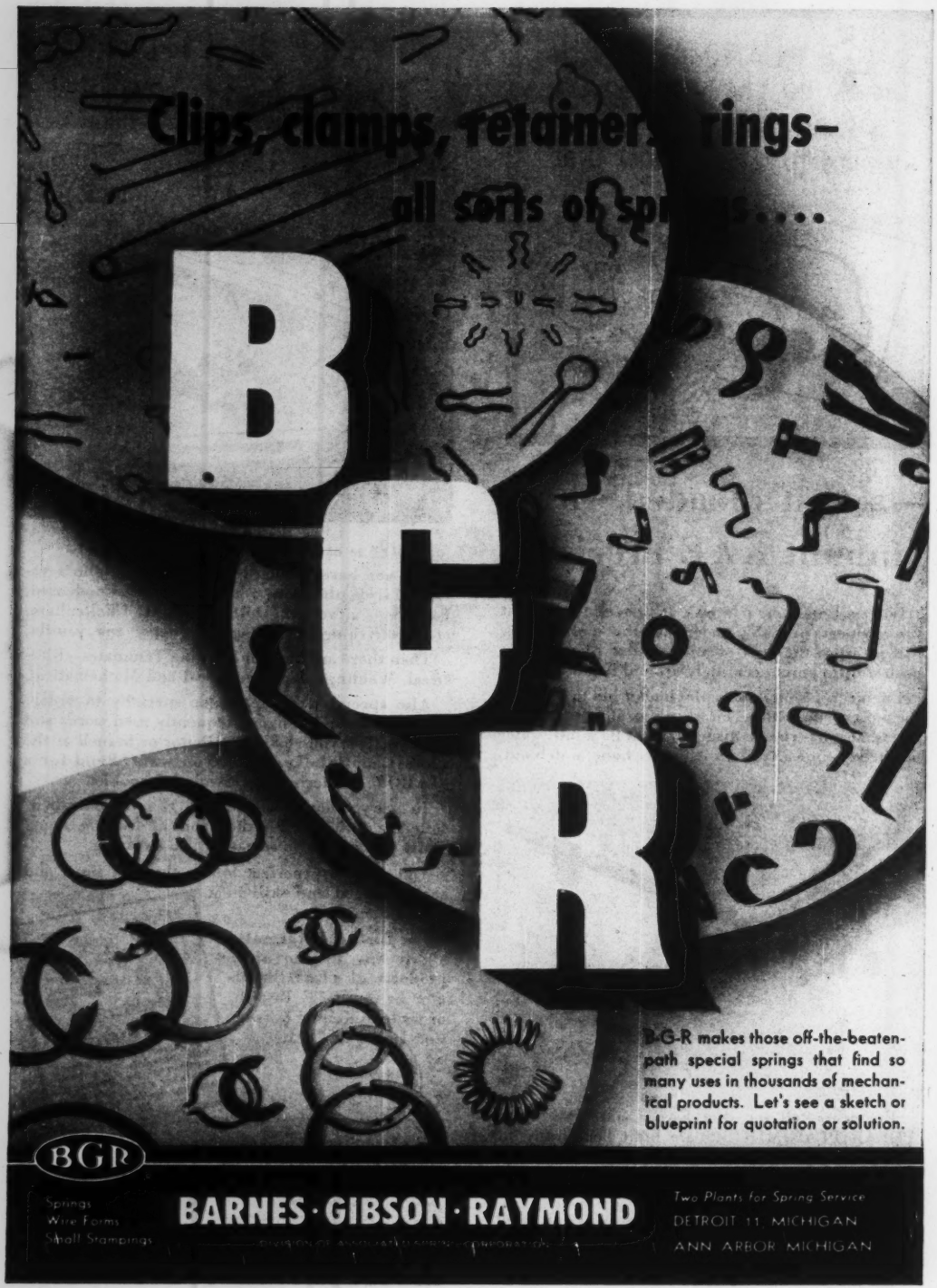
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Take a tip from the people who run Railroads

YOU can date a renaissance in railroad equipment from the time when the first stainless steel streamliners appeared in the 1930's. In stainless steel, railroad management found a material that introduced a whole new set of values . . . so strong that it permits lightweight construction which saves large amounts in fuel costs . . . so corrosion-resistant and everlasting that cleaning, maintenance and depreciation costs are cut to the bone.

The public is benefitted with faster, safer, more comfortable and modern travel accommodations; the roads benefit because stainless steel saves on expenses and increases profits. Today you'll find Allegheny Metal used not only for entire trains, but in dining-car kitchens, sleeping-car equipment, refrigerator cars, and tank cars for the transportation of milk, chemicals, etc.

Rail equipment is only one of the vital uses for stainless steel in general industry and the national defense. In the past decade, we have spent many millions to increase the supply of Allegheny Metal and other alloy products, and are in the process of spending millions more. ● In the national interest, let us help you to use stainless steel most efficiently, and make the available supply go farther.

* * * * *

Complete technical and fabricating data—engineering help, too—are yours for the asking from Allegheny Ludlum Steel Corporation, Pittsburgh, Pa. . . . the nation's leading producer of stainless steel in all forms. Branch Offices are located in principal cities, coast to coast, and Warehouse Stocks of Allegheny Stainless Steel are carried by all Joseph T. Ryerson & Son, Inc. plants.

W&D 3149

You can make it **BETTER** with

Allegheny Metal

AL
TIME-TESTED STAINLESS STEEL

Just 60 SECONDS
from now . . .
. . . a finished
print!!!
. . . with the camera that brings a new speed and
efficiency to oscillograph-recording techniques

The DUMONT TYPE 297

Oscillograph-record Camera

You've just advanced the film after making an exposure. That starts the Polaroid-Land "packaged" developing process. And while you're waiting for its completion—in just 60 seconds—you can start the next exposure or set of exposures. With the Type 297, once you've snapped the shutter, its self-contained, 60-second, developing process lets you forget about the variables of the darkroom.

And with such special oscillographic features as simultaneous viewing and recording, an illuminated data-card, sturdy and easily attached mounting, and overall economy of the Polaroid film, Du Mont has added even greater meaning to this excitingly fast method for "printing" the oscillograph image.

SPECIFICATIONS

LENS—Du Mont-Wollensak f/2.8 or f/1.9, 75mm, coated.

SHUTTER—Wollensak Alphax; shutter speeds of 1/25, 1/50, 1/100 sec. Time and Bulb.

FOCUS—Fixed. May be adjusted for special oscillographic work.

WRITING SPEED—Writing rates of 3.5 in μsec. have been recorded consistently at 12,000 volts accelerating potential.

PRINT SIZE—3¼ x 4 ¼ in.—one, two, three, or more exposures per print.

IMAGE REDUCTION RATIO—2.25:1.

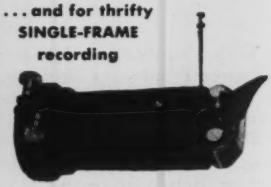
PHYSICAL SIZE—Length, 14⅝ in.; height, 10 in.; width, 6 in.

WEIGHT—12 lbs.

PRICE..... **$285.00** with f/2.8 lens
$355.00 with f/1.9 lens

Write for bulletin on photographic techniques.

. . . and for thrifty SINGLE-FRAME recording



THE DU MONT TYPE 296

Oscillograph-record Camera

The Type 296 is an inexpensive oscillograph-record camera, greatly improved for general-purpose application with any standard 5-inch cathode-ray oscillograph. It incorporates a compact, all-metal, 35mm camera, calibrated shutter and a high-quality f/2.8, 75mm, coated lens which increases its capability 57% over the Type 271-A which it supersedes. Construction is rugged and durable; operation simple and foolproof. The Type 296 weighs only 4½ lbs.

PRICE . . . $149.50

ALLEN B. DU MONT LABORATORIES, INC., INSTRUMENT DIVISION, 1000 MAIN AVENUE, CLIFTON, NEW JERSEY

Remember—only genuine **TUBE-TURN Welding Fittings are identified by these trade marks!**

tt and TUBE-TURN are trade marks of Tube Turns, Inc.

Unique forging process gives strength

TUBE-TURN WELDING FITTINGS have a close-grained metal structure fully as strong as the pipe to which they are welded. Welding elbows, for example, are forged by the only process that achieves wall thickness as uniform as the original seamless pipe . . . guaranteeing *full strength throughout*. And, their true circularity means accurate alignment, regardless of angle, for strong, tight, permanently leakproof connections.

Forged-in strength is inherent with all types of TUBE-TURN Welding Fittings. It's one of the big reasons why it pays to specify them for *all* jobs. Get in touch with your nearby TUBE TURNS' Distributor. You'll find one in every principal city.

Write Dept. F-2 for free booklet giving Dimensional Data on types, sizes and materials of TUBE-TURN Welding Fittings and Flanges.

"Be sure you see the double tt *"*

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles

TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO . . . A wholly owned subsidiary of TUBE TURNS, INC.

Wrought iron downspout welded on Cleveland Bridge

Cleveland's Abbey Avenue Bridge is big enough to collect a lot of water in a rainstorm. To get rid of it, nine downspouts, ranging from 39 to 66 feet in height, carry the water to underground sewers. Wrought iron pipe was chosen for its resistance to rust. All-welded piping was chosen for long life, structural rigidity. Weak joints here could be fatal!

Contractor on this job, the Gorman-Lavelle Company of Cleveland, likes speed on the job. The piping itself was quickly fabricated on the ground, then raised into position. Piping went up fast—and safely!

A lateral connection near the top of the spout leads up to drains on the bridge. TUBE-TURN Welding Reducers are installed at the very top of the spout. The drain sets in the reducer with a loose fit, allowing 2" clearance all around. Thus the bridge can expand on its roller bed without disturbing the pipe. TUBE-TURN Welding Reducers, Elbows, Laterals and Caps are all part of the leading line in welding fittings.

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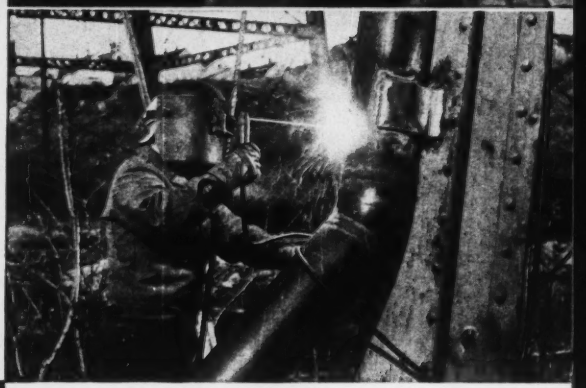
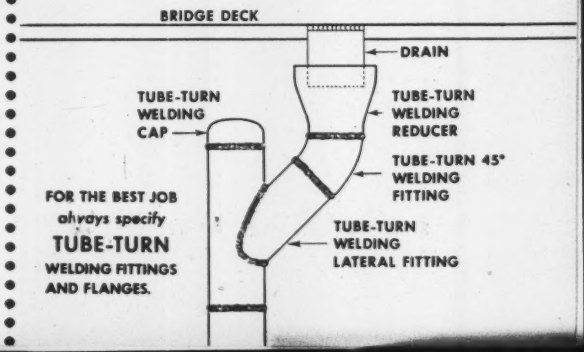
TUBE TURNS, INC.
LOUISVILLE, KENTUCKY



Note TUBE-TURN Welding Elbow at bottom of downspout. Drain pipe will be connected to underground sewer. Underground, too, a system welded with TUBE-TURN Welding Fittings is the best long-term bet—there are no threads to corrode, the problem of leakage is eliminated.


BRIDGE DECK
DRAIN
TUBE-TURN WELDING CAP
TUBE-TURN WELDING REDUCER
TUBE-TURN 45° WELDING FITTING
TUBE-TURN WELDING LATERAL FITTING
FOR THE BEST JOB always specify TUBE-TURN WELDING FITTINGS AND FLANGES.

TUBE TURNS, INC., Dept. F-2
224 East Broadway, Louisville 1, Kentucky

Your Name .....
Position .....
Company .....
Nature of Business .....
Address .....
City ..... *State* .....

the adaptability of this BJ BILTON is more important now than ever!

The production problems to be met in the years ahead may demand a pump that can do more than one job ... a pump that can meet changing conditions of use ... a pump that can be kept in service with a minimum of downtime. That's why now—more than ever—the adaptability of this Byron Jackson Bilton Pump has special importance to you. For more data on the Bilton or a BJ Job-Engineered Analysis of the model for your specific need, contact your local Byron Jackson sales office or write

Byron Jackson Co.

Since 1872

P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

OFFICES IN PRINCIPAL CITIES

BJ

BJ BACKS YOU UP with Nation-wide service and a dependable parts source

SAVES SPACE

... close-coupled motor and pump are constructed in a single unit on a common shaft. No need for rigid foundation or base.

SIMPLIFIES INSTALLATION

... mounts in any position, at any angle, including wall mounting or sling mounting for portable use.

FEATURES INTERCHANGEABLE PARTS

... simplified construction uses fewer parts and allows easy interchangeability of all basic parts.

MINIMUM SPARE INVENTORY

... a small number of spare parts can serve a large number of working Biltons, providing full repair protection with a minimum inventory.

VERSATILE IN APPLICATION

... single-stage models meet all classes of low to medium head service. Two-stage models fill medium and medium-high head service.

AVAILABLE IN SPECIAL CONSTRUCTION

... BJ Mechanical Seal for handling liquids with special temperature, corrosion or pressure factors. Also explosion-proof motor, or other special construction.

LOW HORSEPOWER CONSUMPTION

... close-coupled construction allows more efficient application of power to pump.

WIDE CAPACITY RANGE

... Single-stage models in 1¼, 1½, 2, 2½, 3, 4 and 5 inch sizes. Two-stage in 1½" size. Capacities to 2000 gpm, heads to 475 ft.

3452—Martin R. Klitten Co.—151

BARRIER to SOUND and HEAT } "K" FELT

American Felt Company's "K" Felt is made to Army-Navy Specifications for applications where either sound absorption or thermal insulation, or both, are required. It is in wide use in airplanes, auditoriums, radio studios, and special automobile applications. Suitable for use at temperatures from below zero to 250° F. Made in rolls approximately 24 yards long and 72 inches wide, in thicknesses from ⅛ to ½ inch. Thicknesses over ½ inch are easily produced in your plant by layering. The engineering authority on the use of felt for sound and thermal insulation is American Felt Data Sheet No. 3, "K" Felt. Write for it today.

American Felt Company

TRADE MARK

GENERAL OFFICES: 50 Glenville Rd., Glenville, Conn. ENGINEERING AND RESEARCH LABORATORIES: GLENVILLE, CONN. — PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.

PROPERTY	CHARACTERISTIC
K-Factor	0.21
Noise Reduction Coefficient, 1 in.	0.70
Flow Resistance, gm./sq. cm./sec., 1 in., Spec. AN-S-32	330
√RT/S, Spec. AN-S-32	50
Surface Density, lb./sq. yd./in.	3.24
Tensile Strength, lb./sq. in.	12
Compressive Stress, lb./sq. in. at 50% Deflection	3
Compression Set, 24 hr. loading at 50% Deflection	8%
Temperature Effect, −65° to 250° F.	None
Vibration Disintegration, Weight loss in 12 hrs. at 2000 c.p.m.	0.2%
Physical Stability in Handling or Flexing	Complete
Collapse When Wet	None
Shrinkage-Swell, A.S.T.M., D461	3%
pH Control	6.8-7.2
Corrosive Action, Aluminum, Magnesium and Alloys	None
Chemical Stability	Complete
Moisture Absorption, 24 hr. test at 125° F. and 96% R.H.	28%
Moisture Content, A.S.T.M., D461 Standard Condition, 65% R.H. at 70° F.	16%
Flame Resistance	
Propagation	None
Surface Flash	None
Afterglow, max.	30 sec.
Bacterial, Fungi and Vermin Resistance	Excellent

THICKNESS[1] Inches	SURFACE DENSITY		FREQUENCY Cycles per Second						NOISE REDUCTION COEFFICIENT[2]	CONDUCTANCE C BTU/Hr./Sq. Ft./°F.	RESISTANCE 1/C
	Lb./Sq. Ft.	Lb./Sq. Yd.	128	256	512	1024	2048	4096			
½	0.05	0.41	.02	.04	.06	.12	.28	.44	.10	0.85	1.17
¼	0.09	0.81	.03	.04	.11	.29	.56	.68	.25	0.68	1.47
½	0.18	1.62	.05	.07	.29	.63	.83	.87	.45	0.41	2.44
¾	0.27	2.43	.04	.17	.62	.82	.86	.83	.60	0.28	3.57
1	0.36	3.24	.06	.31	.80	.88	.87	.87	.70	0.21	4.76
										K-Factor	Resistivity
1 ½	0.54	4.86								0.14	7.15
2	0.72	6.48								0.13	7.69
2 ½	0.90	8.10								0.11	9.09

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

It's DOUBLE safe!

DOUBLE

With Type E turbines, you can be doubly sure of protection against overspeed.

A sensitive, powerful centrifugal-weight governor, enclosed in a specially shaped housing, provides extremely accurate speed control.

However, if for any reason the governor loses control, Type E *dual* protection takes over. A corrosion-resistant, spring-restrained weight, mounted in the governor hub, strikes a trip linkage . . . instantly closes the governor valve and an independent steam inlet butterfly valve. Steam is cut off positively . . . danger is avoided.

Dual protection is but one of the many significant features of Type E turbines. We invite your comparison on *any* count. Ask your nearby Westinghouse office for 20-page book B-3896, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50499-A

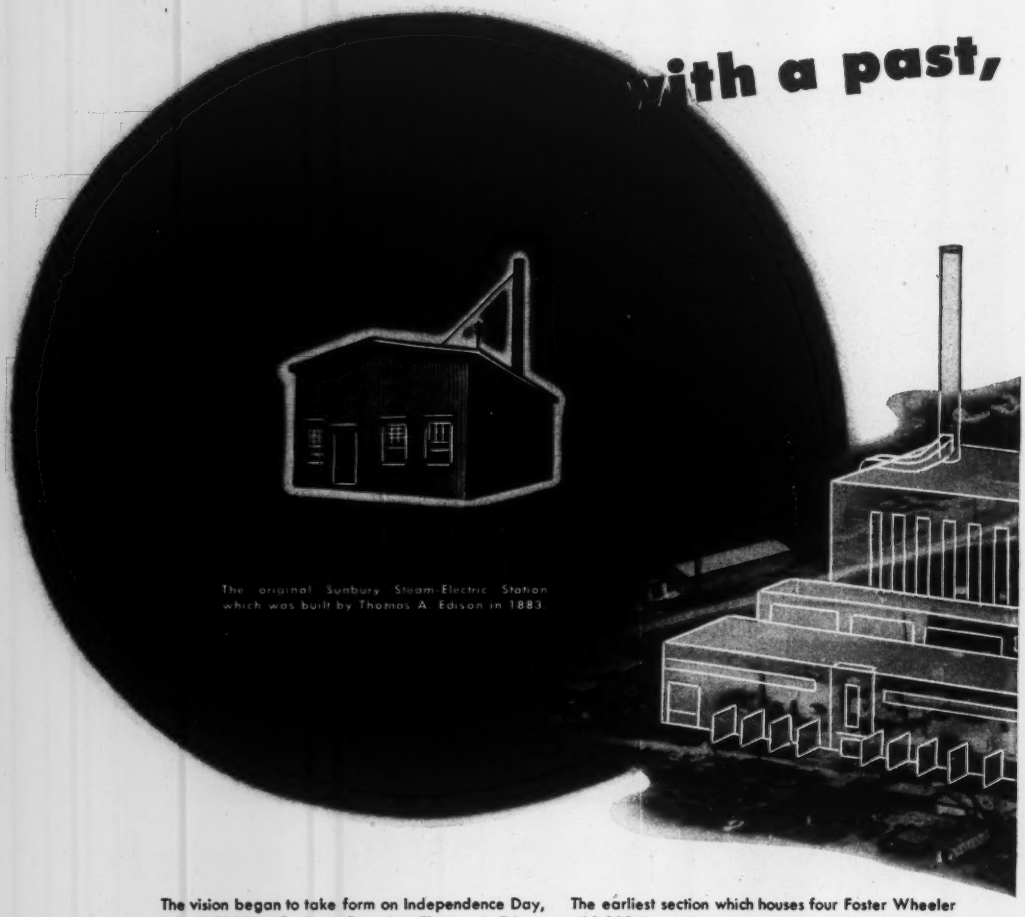
Westinghouse

TYPE E

Turbines

WESTINGHOUSE

ith a past,



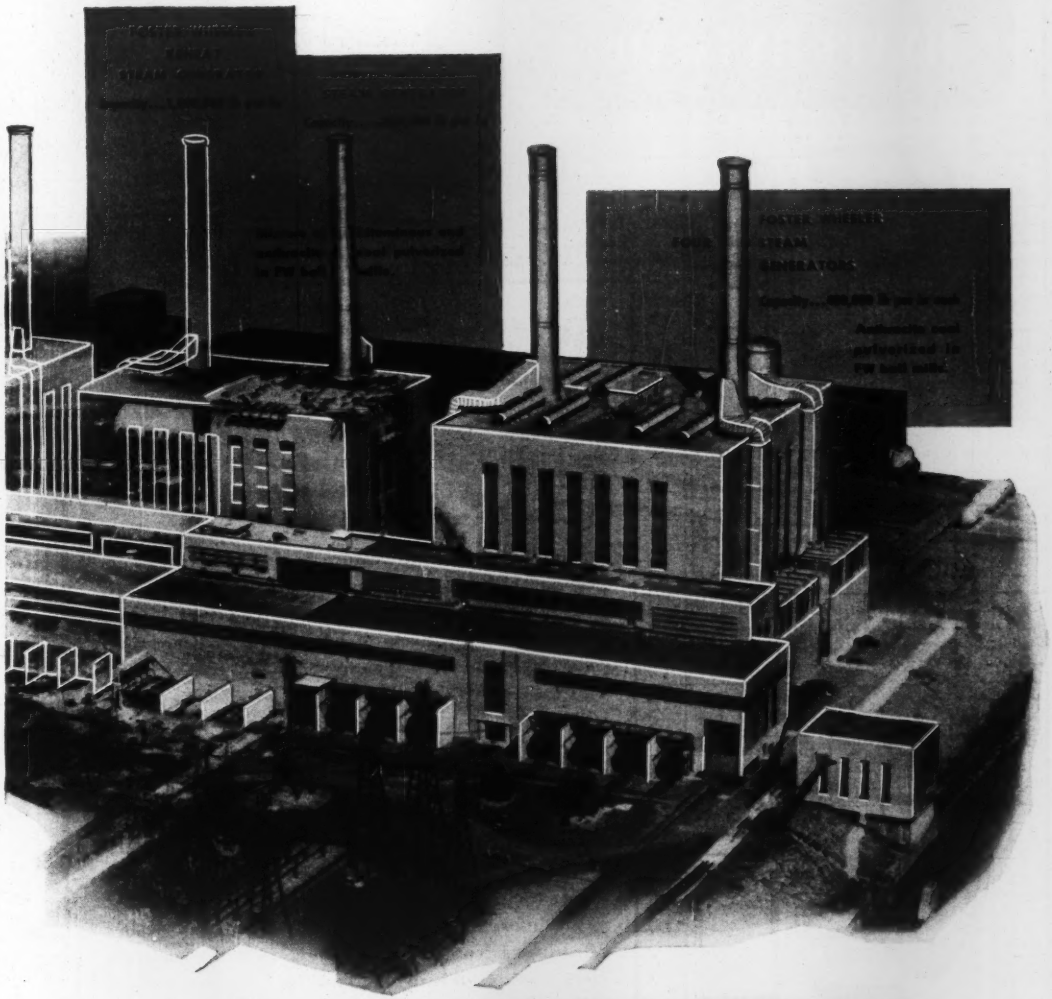
The original Sunbury Steam-Electric Station which was built by Thomas A. Edison in 1883.

The vision began to take form on Independence Day, July 4, 1883 at Sunbury, Pa. when Thomas A. Edison threw the switch of the first commercial steam-electric station in the world. This was one of the epochal events foreshadowing the scientific, industrial, and economic miracles of the 20th century. The new Sunbury Steam-Electric Station near Sunbury, Pa. reflects both the tradition of our American past and the hope of tomorrow as its fine buildings emerge from the blueprint stage to provide an abundant source of power for factories, offices, farms, and homes in Central Eastern Pennsylvania.

The earliest section which houses four Foster Wheeler 400,000 lb per hr steam generators providing steam for two 75,000 kw turbine generators is the world's largest power plant burning pulverized anthracite. The first extension houses a 100,000 kw turbine generator and an 800,000 lb per hr Foster Wheeler steam generator. Engineering is under way for the installation of an additional Foster Wheeler 1,000,000 lb per hr reheat steam generator designed to serve a 125,000 kw unit. When ultimately completed, the station is expected to have a capacity of more than 700,000 kw.

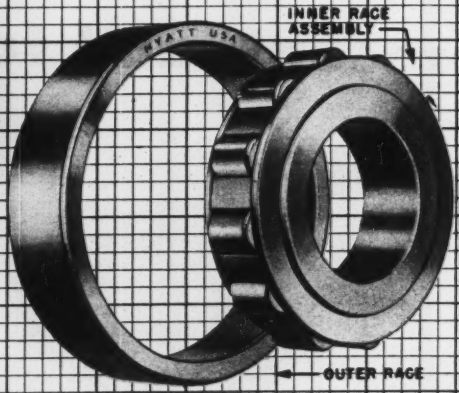
FOSTER WHEELER CORPORATION · 165 BROADWAY, NEW

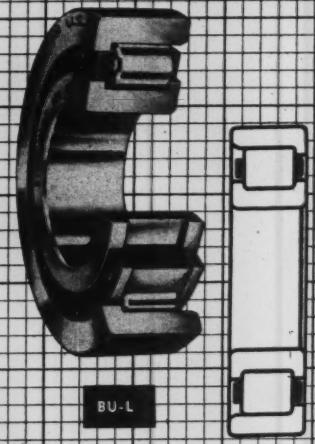
present, and future

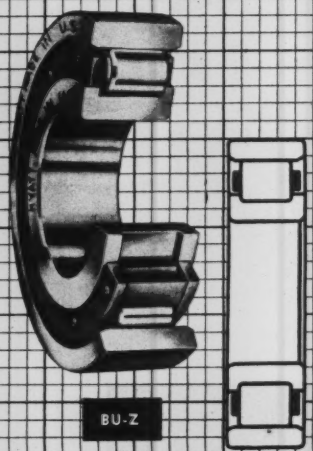


YORK 6, N. Y.

For Separable Outer Race Bearings--
HYATT HY-LOADS







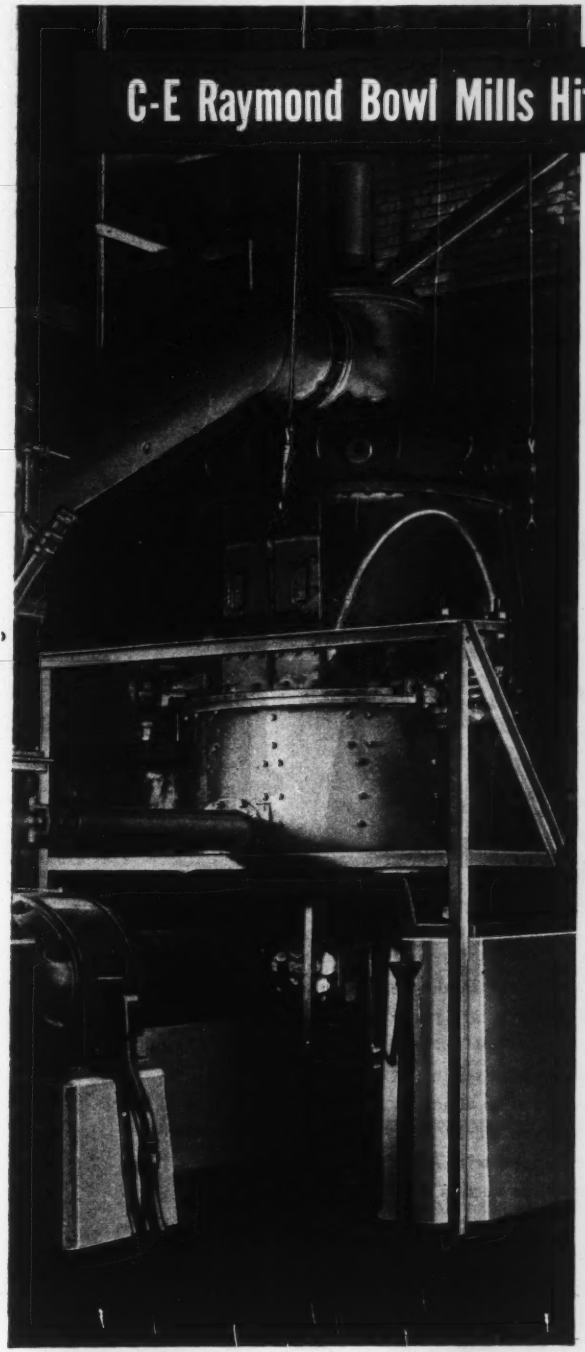
WITH the separable outer race type Hyatt Hy-Load Roller bearing it is possible to omit the outer race and mount the assembly on the shaft with the rollers operating directly in a housing of suitable hardness and finish. When space is limited for the housing bore or a bearing of larger size is desired, this feature of the BU-L and BU-Z Hy-Load Bearings makes them ideal for this type of application.

Another important feature is the complete interchangeability of bearing parts. Any outer race will fit any roller assembly of the same number. This permits the two bearing parts to be mounted in separable machine elements which are then brought together for assembly without worrying about selective fitting. This important Hyatt Bearing feature speeds final assembly, permits more efficient production planning and layout, and often leads to improvements in product design.

In addition to the Hy-Loads with separable outer races there are separable inner race and non-separable types each of which are made in a wide range of sizes. Full information about all Hyatt Hy-Load Roller Bearings is contained in Catalog 547 . . . a complete engineering guide to radial bearing selection and use. Write for your copy today. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

C-E Raymond Bowl Mills Hit New High in 1950



ordered for 5,000,000 kw of new electric generating capacity

Perhaps an even more impressive indication of Bowl Mill acceptance throughout the utility industry is the fact that . . .

. . . if all Bowl Mills purchased by American utility companies from January 1 to December 31, 1950, were to operate at 70% use capacity factor for a year, they would pulverize a total of

20 million tons of coal —

that's about ¼ of the amount of coal used by all utility companies in 1949.

No one factor could possibly account for this widespread acceptance. Rather it is the fact that the Bowl Mill's record of performance in hundreds of installations has been *outstanding* in *all* these important respects . . .

- **power consumption**
- **maintenance costs**
- **control characteristics**
- **ability to maintain capacity with wet coal**
- **ability to maintain fineness through life of grinding elements**
- **quiet vibrationless operation**

Check the facts of Bowl Mill performance on *all* these counts and you will understand why utility engineers continue to accord it such widespread preference. B-457

C-E

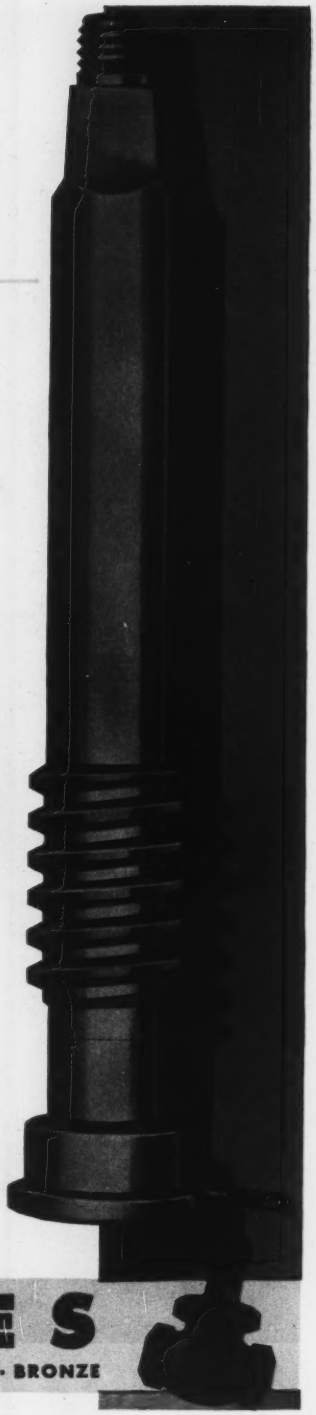
COMBUSTION ENGINEERING-SUPERHEATER, INC.

200 Madison Avenue • New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

THIS STEM WILL LAST LONGER

because it's machined from OIC Alloy 40



Months ago, we introduced Alloy 40 to the field; use has confirmed our laboratory tests. Now, we are ready to tell you about it.

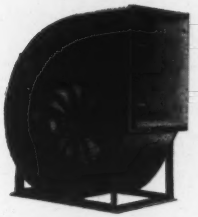
Alloy 40 completely eliminates galling and seizing. It is harder and stronger. It is highly resistant to attack by corrosive liquids and semisolids. It lasts longer!

All OIC Bronze Valves are now equipped with Alloy 40 stems. The Ohio Injector Company, Wadsworth, Ohio.

OIC FOUNDED 1883

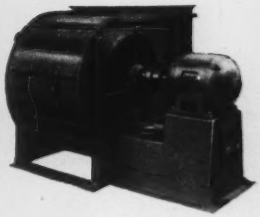
VALVES

FORGED AND CAST STEEL · IRON · BRONZE



LIMIT-LOAD FANS
For large-scale ventilation. Quiet, non-overloading. Sizes up to 500,000 c.f.m. Bulletin 3675.

AXIAL FLOW FANS
For light-duty ventilation and air conditioning service. Compact, non-overloading. Bulletin 3533-C.



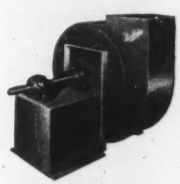
POWER PLANT FANS
Primary, forced draft, induced draft — built for the severest service. Bulletin 3750.

BREEZO FANS
Easy-to-install wall fans. Durable and very economical. 6 sizes. Bulletin 3222-F.

TYPE "CB" PRESSURE BLOWERS
For single-stage pressure blowing up to 2¼ pounds per square inch. Bulletin 3553-A.

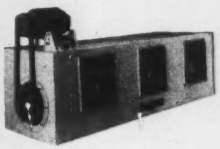
TYPE "CC" PRESSURE BLOWERS
In sizes for pressures up to 4 pounds and capacities up to 75,000 c.f.m. Bulletin 3553-A.

BABY CONOIDAL FANS
Compact, for portable or duct-connected service. Quiet, efficient. Bulletin 3499.



INDUSTRIAL EXHAUSTERS
With interchangeable wheels for air exhausting or materials conveying. All-welded. Bulletin 3576.

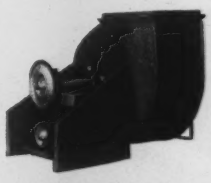
"E" BLOWERS—EXHAUSTERS
For oil or gas furnace blowing, line boosting, cleaning. Bulletin 3014-C.



SHORTBOY VENTILATING SETS
New high efficiency all-aluminum blowers with hollow shaft. Bulletin 3701.

BELT-AIR FANS
Efficient, quiet wall fans for free-air delivery up to 19,000 c.f.m. Bulletin 3222-F.

VOLUME FANS
For blowing or exhausting, up to 10" s.p. 8 discharge positions. Bulletin 3615-A.



BELTED VENT SETS
Compact, "package" fans for duct or free-air delivery. Non-overloading. Bulletin 3720.

"RE" BLOWERS—EXHAUSTERS
Larger versions of "Buffalo" "E" Blowers, in sizes from 50 to 1600 c.f.m., for pressures up to 40" of water.

"Buffalo" **BUILDS THE *RIGHT* FAN FOR THE JOB**

Whether you need to ventilate a small room or an entire factory — clean tools with air or give your boiler system the most efficient mechanical draft — "Buffalo" builds the fan for the job! And whatever "Buffalo" fan you pick, you can know that its performance is backed by 73 years of "air know-how". Take a look at the fans shown here, and write us for engineering bulletins by number on any that might fit your particular application!

BUFFALO FORGE COMPANY
148 MORTIMER STREET, BUFFALO, NEW YORK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Branch Offices in all Principal Cities

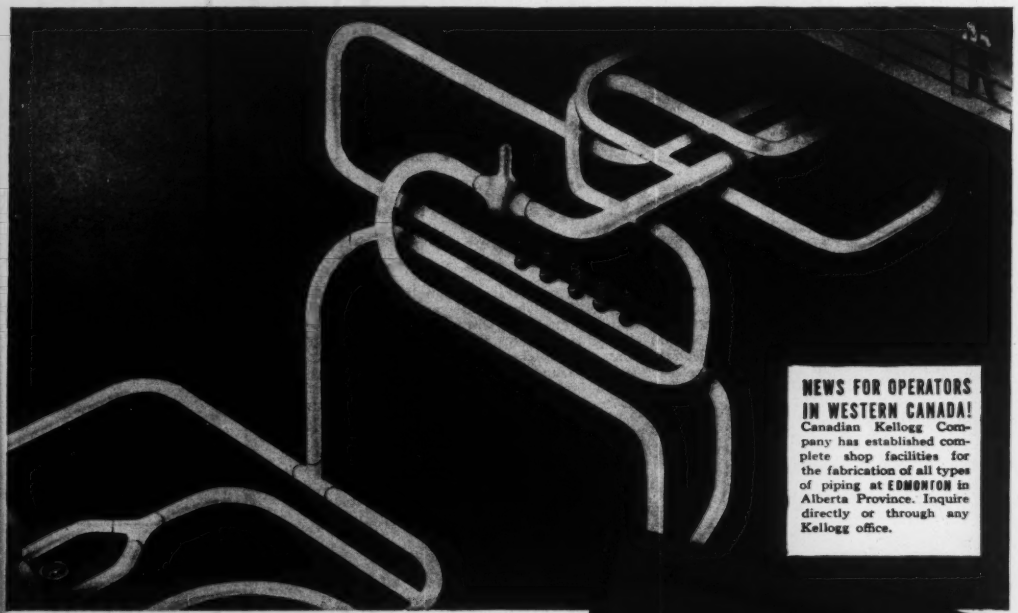
—And For PUMPS . . .

. . . you'll find a rugged precision-built "Buffalo" Centrifugal Pump of the right design, the right metal or alloy and right capacity to handle your liquid-moving job most efficiently. WRITE FOR FACTS!

BUFFALO PUMPS, INC.
148 MORTIMER STREET, BUFFALO, NEW YORK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Branch Offices in all Principal Cities

Note: Thirteen Major Reheat Units...

. . . within a short period, we have contracted to fabricate and install the critical power piping for thirteen major reheat units. These systems are for nine leading utility companies...include designs by six well-known consulting engineers...and have a total operating capacity of more than 1,150,000 kws. In addition, Kellogg power piping has been specified for many traditional-type installations in the U.S., Canada, Europe and South America.



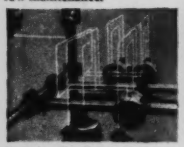
NEWS FOR OPERATORS IN WESTERN CANADA!
Canadian Kellogg Company has established complete shop facilities for the fabrication of all types of piping at **EDMONTON** in Alberta Province. Inquire directly or through any Kellogg office.

Special studies of unusual problems such as graphitization to assure long life and low maintenance.

Metallurgical research by recognized specialists who have made major contributions in this field.

KELLOGG 50th ANNIVERSARY 1901 - 1951

M. W. KELLOGG



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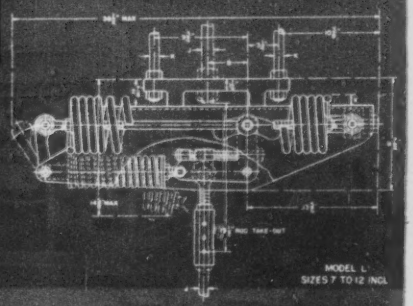

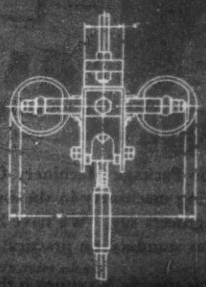

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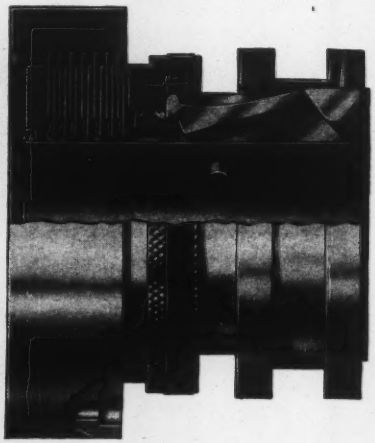

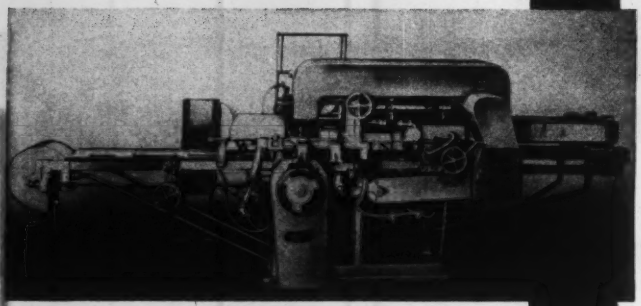

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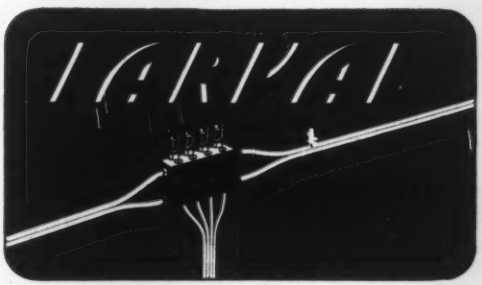

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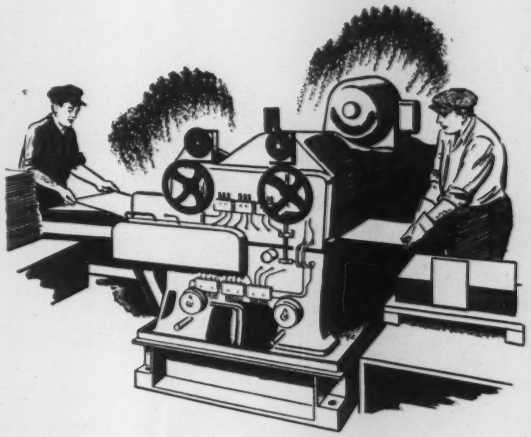

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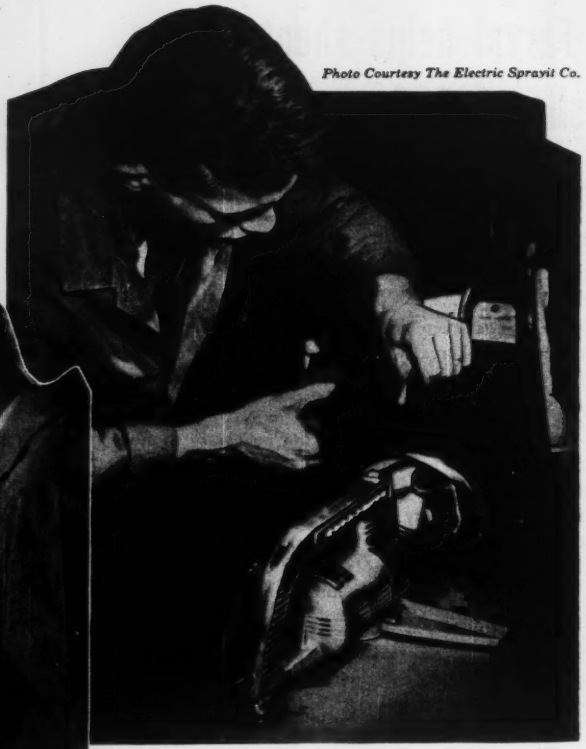

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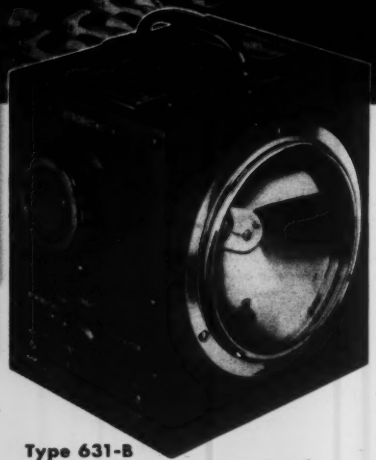

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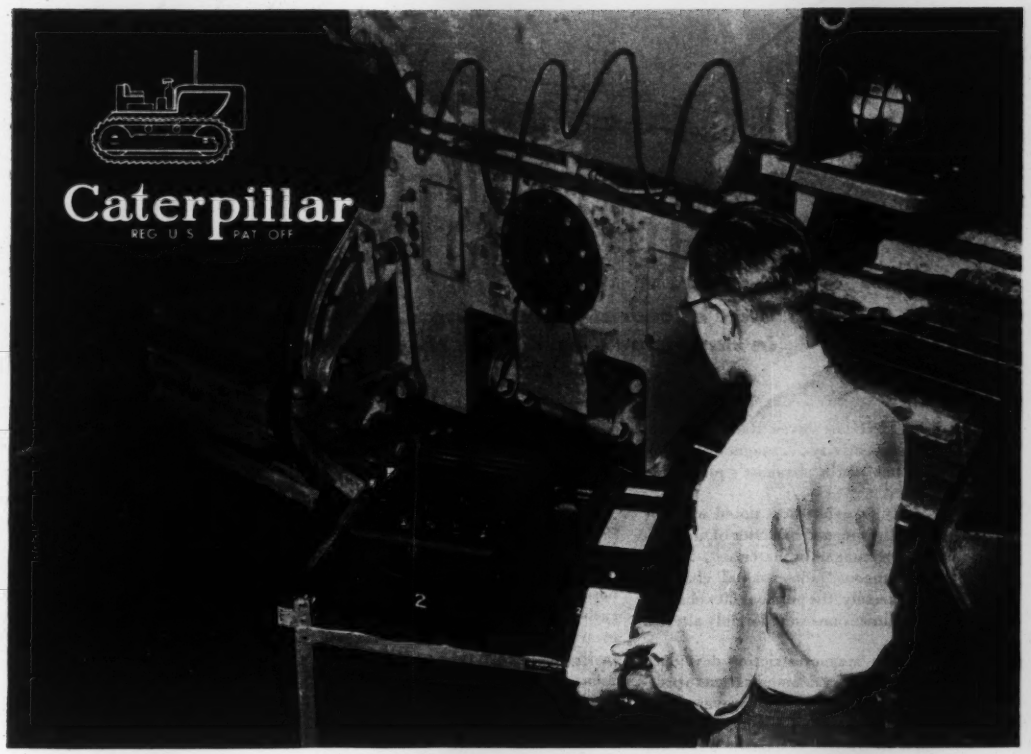

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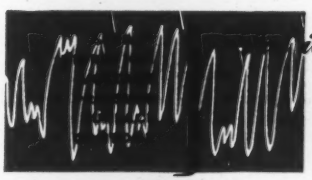

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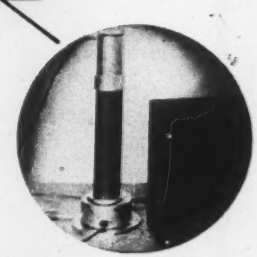

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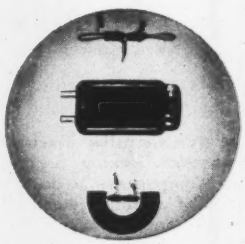

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 73 NUMBER 2

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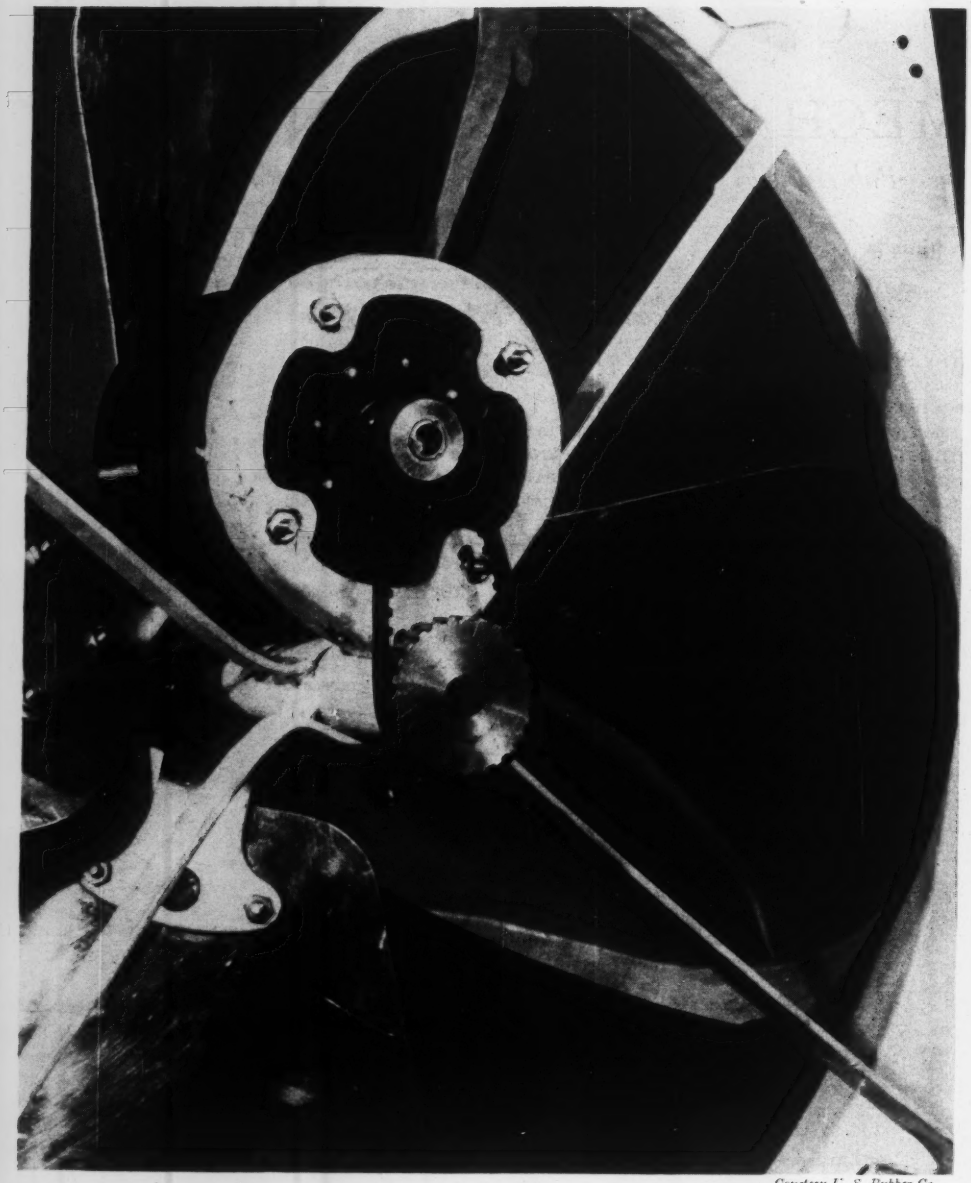

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MECHANICAL ENGINEERING

FEBRUARY
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GEORGE A. STETSON, *Editor*

Critical Manpower Shortage

SCARCELY more than a year ago the press of the nation carried dispatches to the effect that engineering had become an overcrowded profession. Engineering graduates, it said, were unable to find employment. The colleges had just graduated the largest number of engineering students in their history, the number having been abnormally increased by war veterans who were completing their education. A spirit of caution, engendered by uncertain business conditions and fears of the effects of inflation, had led some employers to add fewer engineering graduates than usual to their staffs.

Hardly had high-school students, their parents, and their advisers begun to question how seriously the overcrowding might affect careers in engineering which had been under consideration when the engineering colleges, as the result of a survey, announced that practically every engineering graduate had found employment, and a shortage rather than a surplus of engineers might be expected. The peak of the large classes had been passed and numbers of future graduates were estimated to be decreasing at an alarming rate. Enrollments of freshmen were also on the decline. Even before affairs in Korea began to affect the plans of industry and the need of the Armed Forces for young men, it became apparent that the colleges would be unable to supply the requirements of industry for engineering graduates for a period of several years. Low birth rate during the depression of the 1930's and the virtual cessation of engineering education during the war had combined to reduce enrollment of engineering freshmen and the pool of young engineers with a few years' experience in industry. A critical shortage of engineering graduates was actually facing the nation at a time when demand for them was rapidly rising. Such is the situation as it is seen today.

The facts about engineering graduates, engineering freshmen, and high-school graduates are presented in an article on pages 121–122 of this issue, by S. C. Hollister. A chart which accompanies the article shows what has happened from 1930 to date and the estimates of what is likely to happen from now until 1960. The chart takes no account of the possible effects of the induction of young men into the Armed Forces which will, in all probability, still further reduce the estimated numbers plotted. It shows that, by 1959, our engineering schools will be graduating about half the number of students estimated as needed by the national economy and that enrollments of engineering freshmen will be about half the number needed to provide the graduates required. It shows that the estimated numbers of both freshmen and graduates are below the prewar trends by considerable amounts. It shows an alarming dip in estimated high-school graduations, attributable to the low birth rate of the 1930's. These are alarming facts to face in peacetime. With the inductions of young men for the Armed Forces increasing every month, the critical shortage of engineering manpower over the next decade becomes even more serious. Dean Hollister's article emphasizes the gravity of the situation and suggests what the high schools, employers of engineers, and government agencies might do to make the best of a critical situation. Every engineer can help by being aware of the facts and using his influence to impress on the nation the need to use such engineering manpower as we have to the fullest extent and to make every effort to increase the supply of young men competent to carry on engineering work.

Brains Are Important

THE figures used by Dean Hollister to back up his contention that there is a rapidly developing shortage of engineers do not take into consideration the worsening of the situation made inevitable by the drafting of young men for military service. This phase of the situation is at present in such a state of uncertainty and rapid change that a quantitative assessment of effect is not possible at this time. Dean Hollister points out that "there will not be young replacements for engineering jobs vacated by the calling of recruits or of draftees. There will be only a partial supply of young engineers for new jobs as conversion, retooling, and war production may require. Intercompany pirating will only add to the difficulties of staffing. Robbing the colleges of faculty members for industrial jobs will surely dry up the supply and reduce the quality of training given by the colleges." And he warns: "Government agencies including the Armed Forces must take cognizance of the situation. Plans must be developed whereby the engineering manpower needs of the services and of industry may be so co-ordinated that both will be appropriately served from the limited supply. Industry has the job of supporting the military. To assume that the military needs are paramount or exclusive would be a form of national suicide. A careful planning for utilization of men with engineering training and experience only in categories where such training and experience are mandatory should be undertaken. . . .

Sound policies relating to deferment and the calling of reservists must be promulgated with the objective of maintaining a balanced utilization."

What Dean Hollister is saying is that brains are important. They should be conserved and used wisely in posts where the benefit to the nation is greatest, a proposition equally sound in wartime or peacetime. In a struggle for survival each person must be utilized to the best advantage. Gifted persons and those with special skills, training, and experience, are only too rare. They constitute a valuable asset. Their employment, whether for military or nonmilitary use, must be determined objectively and with view to long-range results.

An objective view of needs and qualifications will certainly place scientists and engineers in the category of gifted persons. Assertion by these groups, either in wartime or in peacetime, that they should be given intelligent consideration is too frequently misunderstood by others as a demand for a preferential treatment based on selfish and snobbish motives. Hence any stand taken, even though it may spring from the most patriotic ideals, is unpopular. The problem, as it affects a peacetime economy, was stated in a pre-Korea pamphlet issued by the Educational Policies Commission entitled "Education of the Gifted."

"Social resistance to accepting the leadership of the gifted in the United States springs in part from a misapplication of our national tradition of human equality. In the days of 'Jacksonian democracy' the false doctrine gained currency that any man is as able as another.

"To the extent that the American people fail to face reality by recognizing that the superior abilities of gifted individuals do in fact exist, they tend to impair the full development and fruition of those abilities, thus denying to themselves a measure of the potential benefits."

In our present situation, outnumbered as we are in manpower resources, it is vitally urgent that we possess and maintain a superiority of brains. This we cannot do if we fail to utilize and to develop our resources of intelligence, inventiveness, education, know-how, and trained skills in both military and nonmilitary fields with an eye not only on the months but the years ahead. It is a patriotic duty to insist that brains are important.

Engineers' Opportunity

DEAN Hollister's article was used as an appendix to a letter which the Engineering Manpower Commission of the Engineers Joint Council sent to Robert L. Clark, director, Manpower Office, National Security Resources Board on Dec. 20, 1950, in support of the EJC Commission's contention that the shortage of engineers demands increased enrollment in the engineering colleges. It will be remembered that on Sept. 6, 1950, Mr. Clark asked EJC to prepare a program "for the most effective utilization of engineers in the national effort to make recommendations as to how such a program could be best administered." Taking the stand that national survival depends on scientific and engineering skills and being concerned about a critical shortage of engineers occurring at a time of urgent need, the EJC Commission made certain proposals, in the letter referred to, which are presented on pages 166–167 of this issue. Briefly and in substance these recommendations call for: (*a*) The registration by Selective Service of every man up to age 70 who might be called an engineer for the purpose of locating all engineering skills so that they can be appraised and made available as needed by industry and the military; (*b*) the establishment of a National Engineering Personnel Board to review registrations, establish criteria for inclusion in a "Reserve," classify registrants, select those with critical skills for military, civil defense, and industrial allocation, advise the President, and administer the Reserve; (*c*) the establishment of the proposed Reserve under the NEPB; and (*d*) the reinforcement of the technical manpower of industry through training similar to the Engineering, Science, Management War-Training Program of the last war.

What the EJC Commission hopes to accomplish by its recommendations is "the most effective utilization and organization of skills now existing in the military and industrial groups and the protection of the latter from less efficient use in the military forces as a result of haphazard application of the Selective Service now in effect."

It will be the task of the present Congress to decide how the nation's manpower is to be mobilized to meet the present emergency. Through the Manpower Office of the National Security Resources Board it will have access to the recommendations of the EJC Manpower Commission and the recommendations offered by the scientists through the National Research Council, the American Chemical Society, and the American Institute of Physics. In taking its decision the Congress faces a grave responsibility. It is to be hoped that the decision will be one that will permit full scope to the abilities of scientists and engineers to serve the country in civilian as well as military posts and in the fields of greatest usefulness. It is hoped that the decision will not bleed the research laboratories, the universities, and the industries of the nation of the only men who can successfully carry on the work that must be done if our disadvantage in terms of manpower is to be overbalanced by using our manpower with foresight and judgment.

If the scientists and engineers are to be permitted to serve where their usefulness will be of greatest value to the nation, then there rests upon them a great opportunity and a grave responsibility. Two wars have demonstrated how success depends to an increasing extent on science and industry. To an even greater extent in the years to come will victory be achieved by the forces that are backed up by the ablest scientists and engineers. Regardless of the form that national legislation may take the engineers face the greatest opportunity yet afforded them to exercise wise and aggressive leadership and to serve unselfishly and with lasting credit to their profession. The EJC Manpower Commission is actively engaged along these lines. Behind them they must have the fullhearted support of the profession.

The INDUSTRIAL STATUS *of* DUCTILE IRON[1]

By A. P. GAGNEBIN

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SINCE the start of the commercial manufacture of "ductile iron"[2] about 18 months ago, this new engineering material has made remarkable progress. The purpose of this paper is to report on the progress made thus far, the properties being obtained, the castings being made, and some of the special features that have been developed which bear on its potential for future growth. It is hoped in this way to provide a panorama of the present industrial status of this material and to present enough information to permit assessing its future role in our industrial economy.

Ductile iron is no longer in the pilot-plant stage but is now a full-fledged engineering material manufactured and purchased on the basis of specifications. Although current production is by no means comparable to that of other engineering materials, its present state could be defined as one of healthy infancy. Up to the present time approximately one hundred companies have been licensed to manufacture ductile iron by The International Nickel Company, Inc., and its affiliated companies, The Mond Nickel Company, Ltd., England, and The International Nickel Company of Canada, Ltd. These companies operate approximately 300 foundries in about a dozen countries. There are about 25 licensees in Europe, Australia, and Asia, and the remainder are on this continent in the United States and Canada. It is estimated that approximately 3500 melt tons of ductile iron were processed last year, and that between 15,000 and 20,000 tons will be processed during 1950, in the United States and Canada. One licensee manufacturing light castings, ranging from a few ounces up to 10 lb in weight, produced approximately 4,000,000 castings in 1950. Another licensee who produces heavier castings is currently manufacturing about 150 tons a month.

Ductile iron is not a single material but is rather a family of materials. As in steel, the matrix structure may be modified by alloys or heat-treatment to produce austenitic, acicular, martensitic, pearlitic, or ferritic structures. Much of the interest to date, from an industrial viewpoint, has focused on the pearlitic and ferritic grades and, consequently, this discussion is confined almost entirely to these grades of ductile iron.

MECHANICAL PROPERTIES OF COMMERCIAL GRADES OF DUCTILE IRON

Four principal types of ductile iron are being produced at the present time and these are shown in Table 1. The first, which has a pearlitic structure, develops about 100,000-psi tensile strength with 2 to 5 per cent elongation in the as-cast condition and provides good mechanical wear resistance. The second, which has a pearlitic-ferritic structure, develops about 90,000 psi tensile strength with 5 to 10 per cent elongation. It is used to obtain a combination of strength and toughness. The third grade has a fully ferritic structure obtained by a short anneal of either of the first two. This one develops 70,000-psi tensile strength with 20 per cent elongation and provides optimum machinability and maximum toughness. The fourth contains higher manganese and more particularly a higher level of phosphorus than those preceding. It is used in applications requiring high strength and stiffness but involving moderate shock. These data were obtained from the licensees and represent some 900 individual test results taken from 1-in. keel bars cast from commercial heats.

In the as-cast condition, ductile iron develops a relationship between tensile strength, elongation, and hardness which is shown in Fig. 1. This is an important attribute of the material since hardness provides an index of the other mechanical properties. A number of castings which have been sectioned and subsequently machined into tensile bars for testing, developed the same relation between tensile strength, elongation, and

TABLE 1 REPRESENTATIVE MECHANICAL PROPERTIES OF COMMERCIAL HEATS OF DUCTILE IRON

Grade	Tensile strength, psi	Yield strength, psi	Elongation, per cent	Bhn	Usual condition
90-65-02	95/105000	70/75000	2.5/5.5	225/265	As-cast
80-60-05	85/95000	65/70000	5.5/10.0	195/225	As-cast
60-45-15	65/75000	50/60000	17.0/23.0	140/180	Annealed
80-60-00	85/95000	65/75000	1.0/3.0	230/290	As-cast

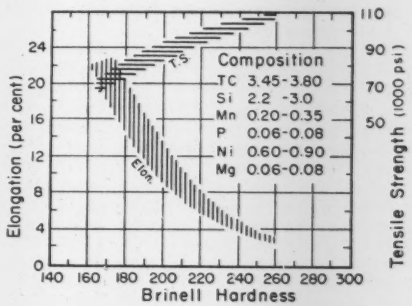
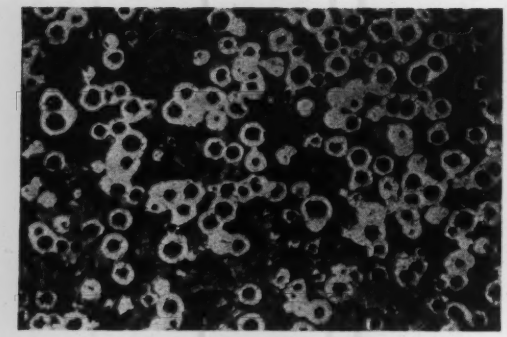
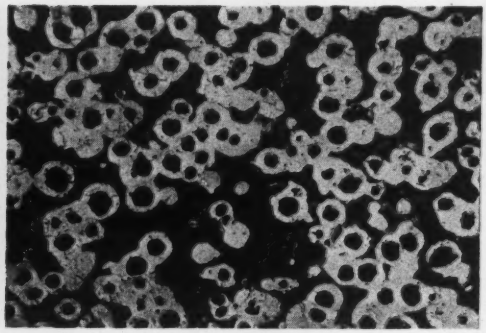


FIG. 1 RELATION BETWEEN TENSILE STRENGTH, ELONGATION, AND HARDNESS OF DUCTILE IRON IN AS-CAST CONDITION

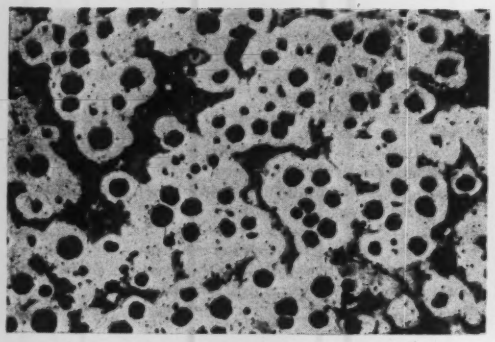
[1] Based on a Lecture given at the Massachusetts Institute of Technology Conference on Nodular Iron, Cambridge, Mass., September 12, 1950.
[2] U. S. Patents Nos. 2485760, 2485761.



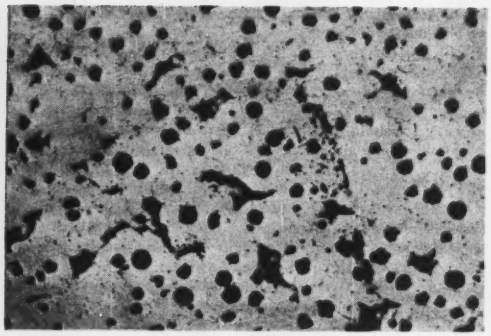
228 Bhn ×50
5.0 per cent elongation



196 Bhn ×50
9.5 per cent elongation



187 Bhn ×50
14.0 per cent elongation



163 Bhn ×50
22.0 per cent elongation

FIG. 2 RELATION BETWEEN THE DUCTILITY AND THE MICROSTRUCTURE OF DUCTILE IRON

hardness as that developed in keel bars. Consequently, in a properly fed ductile-iron casting *of known composition*, a hardness measurement will indicate the strength and ductility of the casting itself. The change in mechanical properties with variation in hardness simply represents changes in the proportion of pearlite to ferrite. The high-strength material is of course pearlitic, while the lower-strength high-elongation material has a preponderantly ferritic matrix.

Fig. 2 shows typical microstructures of ductile iron as well as the relation between ductility and the proportion of ferrite and pearlite in the microstructure. It should be understood that the relation shown in Fig. 1 applies to irons containing no more than 0.1 per cent phosphorus, inasmuch as phosphorus has an important effect upon the properties of ductile iron as will be shown later.

Besides alloying elements which influence the proportion of the pearlite and ferrite formed, the cooling rate of the castings in the mold has an important effect on the microstructure. Castings which cool rapidly tend to be pearlitic while those which cool slowly tend to develop ferrite. Consequently, a light section casting cooling rapidly will develop higher hardness, higher strength, and less ductility than a heavy section casting which cools more slowly. The composition of ductile iron should be harmonized with the cooling rate of the casting in order to produce a hardness level corresponding to the properties desired.

TABLE 2 SUGGESTED U. S. SPECIFICATIONS FOR DUCTILE IRON

Grade	Minimum properties: Tensile strength, psi	Yield strength, psi	Elongation, per cent
90-65-02	90000	65000	2.0
80-60-05	80000	60000	5.0
60-45-15	60000	45000	15.0
80-60-00	80000	60000	No stipulation (By agreement with producing foundry)

Case specimen: One-inch keel bar cast in dry sand.
Test specimen: Standard round test specimen, ASTM E-8, with 2-in. gage length.
Yield strength measurement: 0.2 per cent offset or by dividers method at 0.5 per cent extension under load.

Engineering property specifications (1)[3] for ductile iron have been suggested by The International Nickel Company, Inc., and these are shown in Table 2. They are based on the properties being obtained by the licensees, and there is now con-

[3] Numbers in parentheses refer to the Bibliography at the end of the paper.

siderable ductile iron manufactured and purchased according to these specifications. Specifications eventually will be prepared by code-making bodies, but it is hoped that the specifications in Table 2 will serve usefully during the intervening period.

COMPOSITIONS USED AND EFFECT OF ALLOYING ELEMENTS

The magnesium process is applicable to a wide range of base irons, and a number of compositions are used depending on the properties required and the service for which the castings are intended. The broad composition range along with a few specific compositions being used commercially are given in Table 3.

TABLE 3 COMPOSITION RANGE

	C	Si	Mn	P	Ni	Mg
Broad-range, per cent	3.2/4.2	1.0/4.0	0.1/0.8	0.10	0/3.5	0.05/0.10
Ferritic high-ductility, per cent	3.6/4.2	1.25/2.0	0.35	0.08	0/1.0	0.05/0.08
Ferritic high-strength, per cent	3.4/3.8	2.25/3.25	0.35	0.10	0/1.0	0.05/0.08
Pearlitic high-strength, per cent	3.2/3.8	2.25/2.75	0.6/0.8	0.10	1.5/3.5	0.05/0.08

It is evident that the carbon and silicon contents are higher than those normally encountered in engineering gray iron. Although the magnesium process is applicable equally to both hypo and hypereutectic irons, most of the industrial irons produced are eutectic or slightly hypereutectic in composition. The carbon equivalent, i.e., carbon plus $^1/_3$ silicon, generally ranges from 4.3 to 4.6 per cent. In a broad sense magnesium controls the graphite form but has little influence on the type of matrix structure developed and, consequently, other elements such as manganese and nickel in conjunction with the cooling rate determine the strength and ductility in the as-cast condition.

Nickel and manganese are reduced in order to decrease the strength and increase the ductility, and the upper limits for these elements are lower in grade 80-60-05 than in grade 90-65-02, for example. Carbide-forming elements, such as chromium, should be absent if ductility in the as-cast condition is desired. Phosphorus (2) has a marked effect on the properties of ductile iron because it forms its usual embrittling network and, in addition, appears to stabilize pearlite. It has a minor effect on the strength, but at levels over 0.1 per cent, it sharply reduces the ductility and toughness in the as-cast condition; its effect is milder in the annealed condition.

A few comments should be made on the influence of other common elements because their function is somewhat different in ductile iron from that in gray iron. Silicon is not often used as an alloying element in gray iron because its influence on the matrix properties is overshadowed by its propensity for coarsening the flake graphite. The silicon level is generally governed by the section thickness and the carbon content of the casting being produced. Silicon has no influence on the size and distribution of spheroidal graphite and, consequently, can be used as an alloying element in ductile iron. Some recent data developed on high-silicon irons showed a yield strength of 80,000 psi coupled with 10 per cent elongation in the as-cast condition. It is a powerful ferrite strengthener, and the strength of ferrite is increased by 7000 psi with each additional percentage of silicon.

A question often asked is why the manganese level of ductile iron is lower than that commonly found in gray iron. The reason is that ductile iron is virtually a sulphur-free material and, consequently, none of its manganese is consumed in neutralizing sulphur. In normal gray iron containing 0.1 per cent sulphur and 0.6 per cent manganese, 0.4 per cent manganese[4] is neutralized by the sulphur and only 0.2 per cent is effective as an alloying agent. Consequently, since ductile iron contains no sulphur, it must necessarily contain substantially less manganese than ordinary gray iron in order to develop the same proportion of pearlite and ferrite in its microstructure.

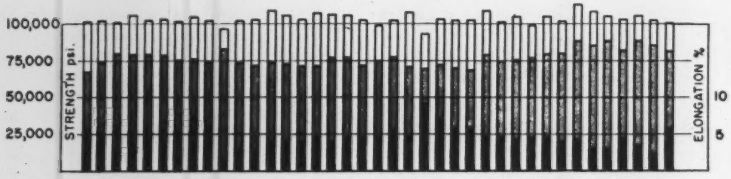
An important although incidental development stemming from these new processes for controlling graphite is that sulphur-free ferrous materials are now available on a commercial scale. Besides possibly leading to new developments in metallurgy, this fact has strategic importance in these times of political disturbance since a large quantity of manganese is obtained from countries behind the "Iron Curtain." The large bulk of the manganese used in ferrous castings is for the purpose of neutralizing sulphur. The malleable-iron industry, for example, which ships 1,000,000 tons of castings containing about 0.5 per cent manganese, consumes a large quantity of manganese in this manner. This industry, by utilizing one of the new processes, such as cerium or magnesium, and lowering the manganese level of its castings from 0.5 to 0.15 per cent, could reduce its requirement for manganese by 7,000,000 lb annually. The same pattern applies in a general way to gray iron and a large part of the cast steel produced.

RELIABILITY OF PROCESS

There has been some fear that the magnesium process is temperamental and cannot be relied upon to produce high-quality material consistently from heat to heat. Fig. 3 shows the day-to-day production of a small foundry (3) in the Middle West producing ductile iron of the 90-65-02 grade requiring a minimum of 90,000 psi tensile strength and 2 per cent elongation. This foundry kept an accurate record of its production for 22 consecutive working days during the entire month of February, and the results show that this foundry has no difficulty in meeting the minimum specifications. It should be noted that this foundry has no chemist or metallurgist and depends on a commercial laboratory some 50 miles distant for its technical control. By following a repetitive pattern, conscientious and intelligent foundrymen can readily produce a consistent grade of ductile iron.

Another fear in connection with the process has been that its effect was momentary and that there would be difficulty in distributing iron in the normal manner after it had been processed. There have been no difficulties in this connection and some irons held in the ladle for as long as 25 min were found to produce spheroidal graphite structures and good mechanical properties. The normal amount of time consumed by a foundry in its usual operational procedure is well within the time limits for the magnesium process. Some data were obtained recently on a 600-lb ladle which was poured into 50 individual castings over a period of 8 min. The keel bars corresponding to the first, 22nd, and 50th castings developed 90,000 to 92,000 psi tensile strength and 7 to 10 per cent elongation. This variation in properties is small and within that normally expected from heat to heat.

[4] Usual formula for calculating the Mn required to neutralize S is $Mn = 2S + 0.20$.



0.505 in. bars cut from 1 in. keel blocks; cooled to black in dry sand cores. Brinell hardness 217-262, average 248.

CHEMICAL ANALYSIS OF TEST BARS

95 per cent spread		Average of all
3.57 –3.81	C	3.67
2.29 –3.01	Si	2.57
0.36 – .51	Mn	.46
0.068–0.109	P	.083
0.010–0.018	S	.013
0.98 –1.45	Ni[a]	1.25
0.066–0.11	Mg	.088

[a] One ladle alloyed to 3.24 Ni. Test bar shows tensile strength 122,500 psi, yield strength 95,000 psi, elongation 2.5 per cent, and Brinell hardness 285 in 1-in. section from keel block.

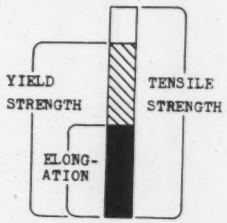


FIG. 3 DAILY RECORD OF MECHANICAL PROPERTIES OF COMMERCIALLY PRODUCED DUCTILE IRON IN ONE FOUNDRY

TABLE 4 MECHANICAL PROPERTIES OF TEST BARS CAST FROM LAST METAL IN LADLE

Composition		1-in. Section			3-in. Section		
C per cent	Si per cent	Tensile strength, psi	Elongation per cent in 2 in.	Bhn	Tensile strength, psi	Elongation per cent in 2 in.	Bhn
3.56	3.31	87500	12.5	202	80000	13.0	170
3.78	2.78	93000	8.0	...	83000	13.5	...
3.74	2.78	92000	8.5	...	84000	10.0	...
3.86	2.13	105000	7.0	235	90500	8.0	207
3.78	2.79	96000	9.0	210	94000	7.0	192
3.74	3.06	87000	9.5	207	79000	9.5	187
3.86	3.42	87500	15.0	196	80000	15.0	179

Nominal: Ni, 0.90/1.25 per cent; Mn, 0.25/0.40 per cent; Mg, 0.06/0.09 per cent; P, 0.10 per cent maximum.

Table 4 shows data on test bars which were cast after all the castings had been poured. The procedure that this licensee shop uses is to process the iron, pour all the castings, and then pour the test bars from the iron remaining in the ladle. The excellence of the properties is self-evident, particularly those obtained from the 3-in. sections. Spheroidal graphite can be produced in any section thickness and the loss in mechanical properties with increasing section is quite moderate.

PRINCIPAL PROPERTIES AND CASTINGS ILLUSTRATING THEIR USE

An important and perhaps the outstanding feature of ductile iron is that it combines the fluidity and castability of cast iron with properties resembling those of steel. There have been a number of component parts which could not be manufactured because they were too intricate to be cast in steel and had inadequate properties even when made of the best grades of gray iron.

New designs for more efficient reciprocating compressors developed by one company lay dormant for a number of years because some of the critical castings could not be produced. Ductile iron has been tested successfully, and it is now possible to produce this machinery. The same situation exists with respect to rotary compressors. There has been a desire for some time to use more efficient refrigerants which have a wider pressure cycle than those now in use, but this could not be done because the complexity of the castings prevented their being cast in steel and they would have been too heavy and bulky to be practicable in gray iron. The advent of ductile iron has made it possible to produce these complex castings and one example is shown in Fig. 4. The combination of castability and high mechanical properties in ductile iron deserves considerable emphasis because it is believed to have an important bearing upon its potential use, and it is a feature which will become increasingly evident in new machinery designed to take advantage of the special qualities of ductile iron.

PRESSURE CASTINGS

It is expected that ductile iron will find wide use in pressure castings. These are usually difficult to cast and also difficult to produce pressure-tight. There are many examples of gray-iron

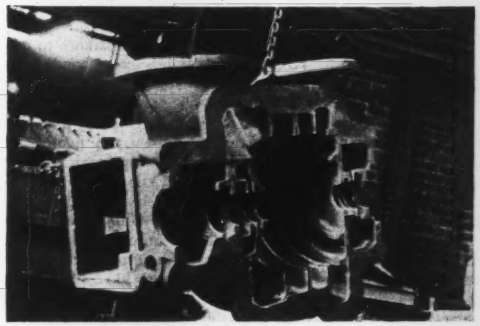


FIG. 4 ROTARY-COMPRESSOR CASTING

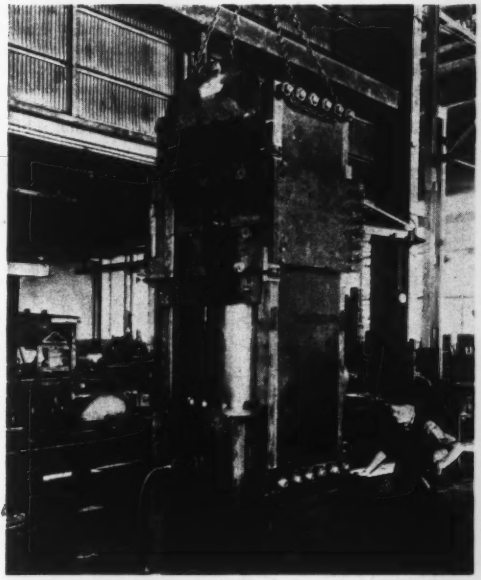


FIG. 6 CYLINDER AND PISTON OF THIS HYDRAULIC PRESS ARE CAST IN DUCTILE IRON

castings which appear to be metallurgically sound and yet which leak. This comes about from the fact that a continuous path can develop via coarse graphite flakes with the result that seepage occurs. Obviously, such a situation cannot exist in ductile iron because of the shape and distribution of the graphite.

Examples of pressure castings are the hydraulic-jack body, the cylinder and piston, and the rotary water pump shown in Figs. 5 to 7. The jack body is now a production item and gives no difficulty even though this casting operates a pressure of 8000 psi. Many large press cylinders, some weighing up to 20,000 lb, and more complex than the one shown, are being produced successfully. It is believed that a large potential market exists for ductile-iron pipe, shown in Fig. 8, and which has been described in detail elsewhere (4). In hydrostatic tests on 8-in. pipe, gray iron shattered at pressures of 2200 to 2400 psi whereas ductile iron bulged at 5100 to 5300 psi and subsequently split along the bulge. Besides requiring less maintenance in water distribution systems because of its better ability to withstand ground shifts, it is expected that ductile iron will be used for transmitting gases and fluids which are barred to gray iron because of its lack of toughness. Fig. 8 also demonstrates that the arc-welded joint in ductile iron was stronger than the pipe itself in hydrostatic tests. Ductile-iron valves and fittings also will be produced in large quantity.

STIFFNESS

Ductile iron has a modulus of elasticity of about 25,000,000 psi and as a consequence of its high stiffness there is considerable interest in its application for printing press, paper mill, and

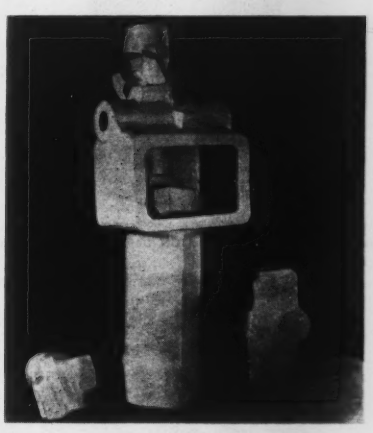


FIG. 5 HYDRAULIC-JACK BODY

FIG. 7 BODY AND COVER OF ROTARY WATER PUMP

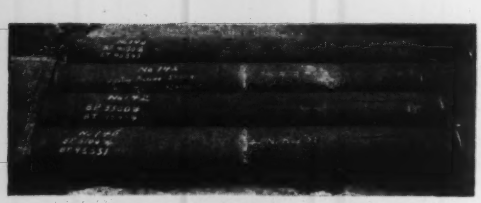


FIG. 8 DUCTILE-IRON PIPE AFTER HYDROSTATIC TESTS

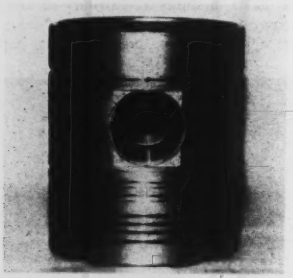


FIG. 9 DIESEL-ENGINE PISTON CAST IN DUCTILE IRON

FIG. 10 DUCTILE-IRON SPROCKET AND BEVEL-GEAR CASTING USED IN AN AGRICULTURAL IMPLEMENT

other types of rolls. Steam-heated drier rolls have attracted particular attention because of the possibility of reducing wall thickness to achieve more rapid transfer of heat. Drier rolls up to 130 in. in length have been produced. Printing-press and metalworking rolls are also being made of ductile iron. Cylinder heads for heavy-duty Diesel engines are being produced and benefit from such properties as stiffness, high strength, and toughness.

HIGH YIELD STRENGTH IN COMBINATION WITH TOUGHNESS

Castings requiring this combination of properties are too numerous to detail. Agricultural implements, road maintenance, mining and milling machinery, and in fact, machinery of all types require castings of this category. Ductile iron is being utilized in many castings for this purpose, ranging from "C" clamps (5), which weigh a few ounces, up to anvil blocks for forging hammers (6), weighing 100,000 lb. The latter require a high yield strength to resist mushrooming under the die block and, obviously, require toughness and fatigue resistance to resist the continual impact loads.

WEAR RESISTANCE

Ductile iron has demonstrated outstanding resistance to mechanical wear in both lubricated and unlubricated conditions. Tests run with no lubrication by a piston-ring manufacturer revealed that its wear resistance was comparable to that of the best piston-ring grade of open-grained flake-graphite iron, one of the most wear-resistant materials known. A number of field tests have also demonstrated the exceptional wearing quality of this material in the lubricated condition. One recent example concerns a comparison between annealed ductile-iron bearings and bronze bearings in the roll-out table of a sheet mill. It is estimated that ductile iron provides a service life 4 to 5 times greater than that of the bronze and at one third the initial cost. Other similar tests have been made with the result that ductile iron is finding increasing use in wear applications such as gears, cylinder liners, and Diesel-engine pistons which are now standard equipment on several models. One of these is shown in Fig. 9. The wearing quality in combination with strength and toughness makes it useful on many agricultural-implement parts similar to the sprocket and bevel gear shown in Fig. 10. Ductile iron is readily flame-hardened to 550 to 600 Bhn and some applications make use of this feature to improve its wear and its abrasion resistance.

A considerable quantity of ductile iron is being used for dies both in the as-cast and in the hardened condition. Fig. 11 shows a $7^1/_2$-ton fender die for a 1951 automotive section, while

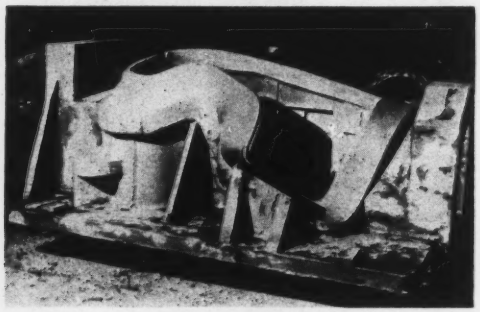


FIG. 11 DIE FOR AN AUTOMOBILE FENDER WEIGHING $7^1/_2$ TONS

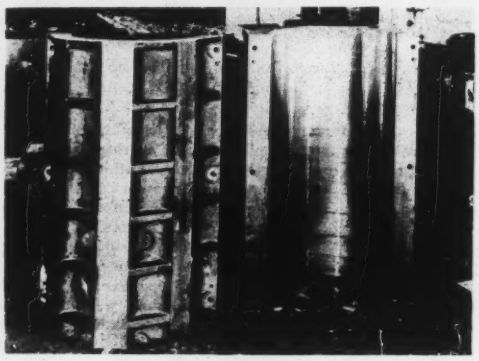


FIG. 12 DUCTILE-IRON PIPE-FORMING DIES

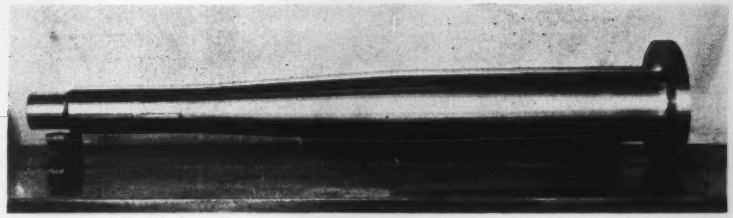


FIG. 13 DUCTILE-IRON GENERATOR SHAFT

TABLE 5 MACHINABILITY RESULTS ON GRAY AND DUCTILE IRON[a]

Material as-cast	Bhn	Ult. tensile strength, psi	Elongation per cent	Cutting speed, fpm: For tool life corresponding to 200 cu in. of metal removed	Cutting speed, fpm: For tool life of 60 min
Acicular—flake graphite	263	59700	0	150	160
Ductile iron	265	97250	2	200	210
Gray iron	225	45000	0	310	280
Ductile iron	215	93000	4	310	315
Gray iron	195	35000	0	325	320
Ductile iron	207	84700	17.5	420	370
Annealed					
Ductile iron	183	77000	20	600	500
Gray iron	100	15700	0	960	810
Ductile iron	170	70000	22	970	680

Criterion of tool life	0.030 in. land wear
Feed (roughing cuts)	0.010 in. per revolution
Depth (roughing cuts)	0.100 in.
Tool	Carbide (K6) 6° true rake
Lubricant	none

[a] Machinability program carried out under contract by Curtiss-Wright Corporation for U. S. Air Force. Machinability tests by Metcut Research Associates, Cincinnati, Ohio.

Fig. 12 shows pipe-forming dies for a large press which have produced over 100 miles of pipe. The latter forms 40-ft lengths of 1/4 to 1/2-in. plate into pipe which is subsequently longitudinally welded. The high strength, toughness, and ability for self-lubrication (7) are factors which contribute to the excellent performance of ductile iron in die applications.

FATIGUE RESISTANCE

Ductile iron has fatigue resistance (8) in both the notched and unnotched condition equivalent to that of the ordinary grades of steel. A number of large generator shafts, one of which is shown in Fig. 13, as well as a variety of crankshafts, utilize this property along with those of good torsional strength, stiffness, and wear resistance.

ABRASION RESISTANCE COMBINED WITH TOUGHNESS

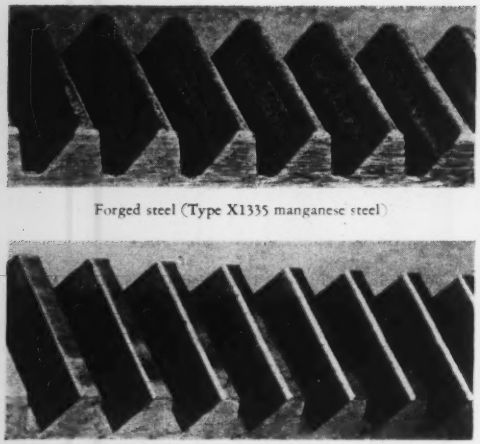
A unique property of ductile iron is its ability to combine a chilled, carbidic, abrasion-resistant area supported by tough ductile material. No other single material can combine these properties, and its only counterpart is a tough material coated with a hard welded overlay. This combination is utilized in ductile-iron plow points, and many thousands have been produced. Heretofore, the choice has been either a chilled-iron point with good abrasion resistance but susceptible to breakage in rocky soil, or a cast-steel point with adequate toughness but inferior abrasion resistance. This combination of properties has also found application in earth-digging equipment and in ore-chute liners and will undoubtedly find many more in sand, gravel, and mining equipment.

HEAT RESISTANCE

Field-service records indicate that ductile iron is outstanding in heat-resistance applications such as furnace doors, grate bars, supports for soaking-pit covers, and certain blast-furnace castings. Forging-furnace doors (9) of ductile iron had a life of 17 weeks, for example, in contrast to gray-iron doors which lasted 4 weeks. The shape and distribution of the graphite greatly retard the penetration of oxidation which is primarily responsible for the destructive growth in ordinary iron exposed to elevated temperatures.

MACHINABILITY

Extensive machinability data have been obtained on ductile iron which have been reported in detail (10). A few of the results are summarized in Table 5 which compare a variety of gray irons and ductile irons, and only two of the outstanding results will be discussed here: One is that as-cast ductile iron having a tensile strength of 93,000 psi has the same machinability rating as gray iron with a strength of 45,000 psi. The other is the remarkable machinability of ductile iron in the annealed condition. Here is a material that can be machined at a cutting speed of 960 fpm and at the same time has mechanical properties of 70,000 psi tensile strength and 22 per cent elongation. Annealed ductile iron can be machined at a rate 2 to 3 times that of good-quality gray iron. This means that the output for each machine tool can be doubled or tripled if annealed ductile iron is used instead of as-cast gray iron. Stated in another way, the same daily output can be achieved with considerably fewer machine tools using annealed ductile iron rather than as-cast gray iron with all the attendant savings in capital investment, floor space, and labor. The machinability of annealed ductile iron contributes markedly to lower cost, and there are many parts which will cost less in the finished



Forged steel (Type X1335 manganese steel)

Ductile iron

FIG. 14 APPEARANCE OF GEAR TEETH ON DUCTILE-IRON AND FORGED-STEEL RACKS AFTER 1500 HR TEST AT 50 PER CENT OVERLOAD

machined condition than those made of other materials even though the raw castings may cost somewhat more in ductile iron. A further advantage is that annealed ductile iron combines a tensile strength of 65,000 to 70,000 psi with 20.0 per cent elongation which means higher quality in the component part than when it is made of gray iron. A further feature is the possibility of weight reduction with no sacrifice in strength.

Ductile iron is expected to find wide application in many engineering parts because it embodies a broad combination of useful properties coupled with a favorable competitive cost position. A recent example clearly demonstrating these points concerns a comprehensive test made on a home-appliance part. The standard material for this part was a steel forging made of sulphurized SAE 1335 steel, with a hardness of 200 Bhn. Tests run for 1500 hr at 50 per cent overload revealed that the two critical zones on these forgings, a gear rack and a bearing hole, were both badly pitted and worn. Ductile-iron parts which were used in the annealed state at 175 Bhn were in excellent condition at the end of the tests with the gear rack and bearing hole having developed a burnish during the test cycle. Fig. 14 shows the condition of the gear racks at the end of the 1500-hr test. The finished cost of the ductile-iron part is 40 per cent that of the steel forging. There are literally thousands of similar component parts which require the strength of steel and whose service lives would be greatly benefited by better resistance to mechanical wear. Needless to say, the reduced cost resulting from the use of ductile iron is an attractive feature.

Another extensive test was made by an agricultural-implement manufacturer involving the replacement of a weldment and a bronze casting with ductile iron. Field tests of 1200 ductile-iron castings in these two applications were entirely successful and proved that ductile iron could be used in these applications requiring high strength and toughness. The estimated savings achieved by this plant in using ductile iron for these two items amounts to $50,000 annually.

CONCLUSION

Ductile iron will find extensive use in a variety of engineering fields not only because its individual properties are exceptional but also because it provides a unique combination of properties not achieved by other common engineering materials. Such features as its excellent castability and fluidity, its high yield strength, toughness, wear resistance, and machinability contribute individually and collectively to its highly favorable competitive position.

Viewed in another way, it can be said that ductile iron combines the process advantages of cast iron with the product advantages of steel. In addition, it retains two important product advantages of cast iron, viz., its machinability and its mechanical wear resistance. In view of these features, it is expected that ductile iron eventually will become the third ranking industrial material on a tonnage basis. Steel is now manufactured at a rate of 100,000,000 tons annually, cast iron at 12 to 15,000,000 tons, cast steel and malleable iron at 1,000,000 tons each, while the production of all other metals is measured in pounds. We sincerely believe that within the next few years, ductile iron will be produced at a rate of 2,000,000 to 5,000,000 tons annually and will accordingly become the third ranking material in our industrial economy.

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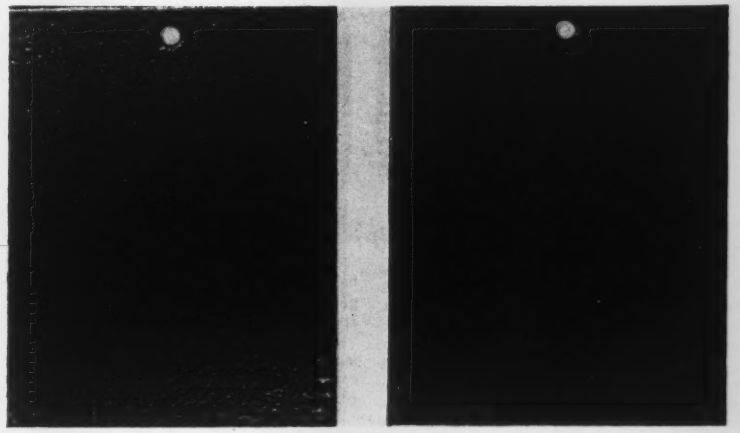

(*a*) Fired in air (*b*) Fired in inert atmosphere

FIG. 1 GLASS-LINED. 84 PER CENT CARBON STEEL

GLASS *as a* COATING *for* STEEL

Some Examples of the Functional Use of Glass-Coating Process

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THE virtue of glass as a steel-coating material derives mainly from the fact that the surface characteristics of glass are retained and are made more useful by the addition of the characteristic strength and flexibility of the base metal to which the glass is fused.

The base metal generally used in this combination material is usually iron or steel, although copper and stainless steel may also be used where the commercial application justifies the extra cost. The glasses used in this type of product are true members of the glass family. The basic constituent is silicon dioxide, commonly occurring as sand or quartz. Many other mineral materials are used in the raw batch of the glass. Although the silica is relied upon as the main glass-forming element, the compositions most generally used may be classified simply as an alkaline aluminum-borosilicate.

BASE METAL AND FURNACE ATMOSPHERE

In the commercial work described in this paper, one or the other of two types of steel is generally used. The analyses are given in Table 1.

The steel on the left is a rimmed steel characterized by very low metalloid content, and it may be noted that the carbon and manganese are both held to a low value. This type of steel is made primarily for porcelain enameling and glass coating. A minimum of difficulty is encountered in applying glasses to this steel, and a low carbon content aids in minimizing warpage of the steel when the furnace temperatures are in the neighborhood of 1600 F.

TABLE 1 TYPICAL ANALYSES OF GLASS LINING STEELS

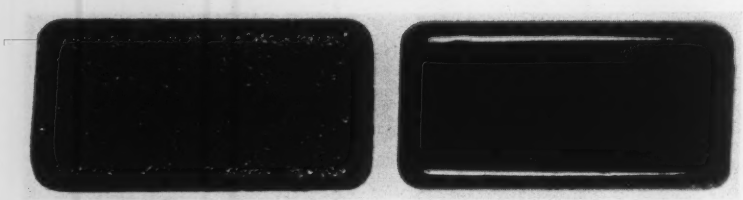
	Water heaters	Glass-lined tanks
C	0.02	0.09
Mn	0.04	0.48
Si	0.007	0.01
S	0.025	0.03
P	0.004	0.02
Total	0.096	0.63

The steel on the right is usually made as a rimmed type of steel, and the metalloids are sufficiently low so that the glass-coating process can be carried out satisfactorily.

While these steels are most generally used, special products may require the use of other base metals. In some cases the chemistry of the base metal is such that the metal is not compatible with the glass during the furnace operation. A case of this type is illustrated in Fig. 1. If this 0.84 per cent carbon steel is coated with glass and the atmosphere in the furnace is air, the glass becomes blistered and unsatisfactory, as shown in sample (*a*). However, if the same steel and the same glass are put into a furnace where the air is excluded by the introduction of oxygen-free gases, the glass may be fired down with a satisfactory quality.

A further illustration of effective furnace atmospheres may be seen in Fig. 2 in which sample (*a*) is of cast-iron base metal and the furnace atmosphere was air. Sample (*b*) is entirely satisfactory in quality of glass because it was fused in a furnace wherein the oxygen was excluded from the atmosphere.

Contributed by the Process Industries Division, and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly condensed.



(*a*) Fired in air (*b*) Fired in inert atmosphere

FIG. 2 GLASS-LINED CAST IRON

BONDING BETWEEN GLASS AND STEEL

Fig. 3 is a photomicrograph showing a cross section of glass and steel which has been ground and polished to show the nature of the interface between the two materials. Upon close inspection, it may be noticed that the glass has fused directly to the steel in such a manner that fingers of each material, overlapping into the other material, produce a high degree of mechanical bonding. It can be demonstrated that in addition to this mechanical bonding, proper formulation and processing of the glass will produce a wetting of the base metal by the glass. As a result of this wetting, a high degree of adherence develops which is of a different nature from the mechanical bonding described. Actual physical tests have shown that the bond between the glass and metal is of the order of 5000 psi.

GLASS-LINED STORAGE TANKS

Glass-coated steel for many years has found one of its most practical and satisfactory uses in the manufacture of large storage tanks. The highest development of the manufacture of glass-lined storage tanks may be illustrated in the vessels which are used for storage so extensively in the beverage industry. These tanks are often manufactured over 11 ft diam and 42 ft in length. The preferable design is a single-piece welded construction. After fabrication, all of the welds are chipped and ground smooth on the inside, and the tank is then prepared by sandblasting the entire interior perfectly clean. After this operation the glass is applied by spraying the water suspension directly onto the steel. After the interior has been dried completely, the tank is placed on the hearth of a car-bottom furnace which has previously been thoroughly heated well above the desired fusing temperature.

Fig. 4 illustrates one of these large tanks just as it is ready to be removed from the hearth of the furnace after the fusing operation. Special handling devices had to be developed to remove the red-hot tank from the car bottom. Such a tank increases several inches in length during the heating cycle and the tank must be supported in such a manner that the increase in length can take place without restraint.

After the various steps in the manufacturing process have been completed, inspection of the interior of the tank reveals that it has acquired a complete and continuous coating of smooth glossy glass. Fig. 5 illustrates to some degree the nature and appearance of the interior of such a tank.

In the brewing industry great batteries of such tanks are used for aging. Fig. 6 illustrates a finished installation and conveys some idea of the sanitary operating conditions which prevail.

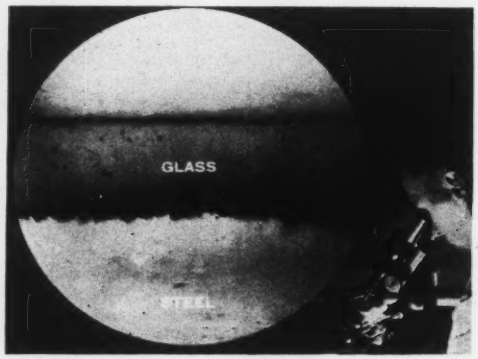


FIG. 3 PHOTOMICROGRAPH OF GLASS AND STEEL INTERFACE; × 200

FIG. 4 SINGLE PIECE, GLASS-LINED TANK EMERGING FROM FURNACE AT 1600 F

FIG. 5 INTERIOR OF SINGLE PIECE, GLASS-LINED STORAGE TANK

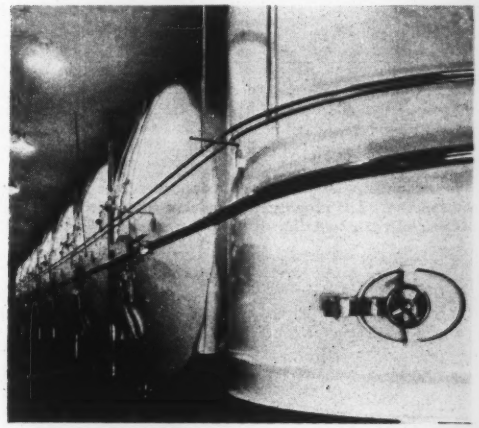


FIG. 6 GROUP OF GLASS-LINED STORAGE TANKS INSTALLED IN STOCKHOUSE AGING ROOM

GLASS-LINED WATER-HEATER TANKS

Storage of hot water in the home has long been a serious problem, particularly in some sections of the country where the available water supply is corrosive in iron.

A satisfactory answer to the problem has been found in the tank and water heater which is shown in cross section in Fig. 7. A model shown is a gas-fired, automatic, storage-type water heater wherein the products of combustion are led through the tank in a central flue.

Entirely different manufacturing problems arise in the manufacture of this relatively small tank as compared to the manufacture of the large storage tanks previously described. When this unit has been completed, the interior can be inspected only through the standard $^3/_4$-in. tapped openings. Therefore it is imperative that the glass lining be inspected thoroughly before the fabrication of the tank is completed. The design of this tank is such that the cylinder, or body of the tank, is fabricated and glass-lined separately from the heads and flue. In fact, each piece of the tank proper is glass-coated while entirely separated from the other members of the tank. Thus each part of the tank may be inspected readily to determine that the glass coating is entirely complete and continuous, and of the proper thickness.

Under present-day methods of manufacture, electric welding is the most feasible method of joining the parts of the tank which must stand a high-pressure test. In some cities in this country, water pressure may reach as much as 125 psi. Suitable safety factors, of course, must be incorporated in the design of such a unit.

In order to permit electric welding after the glass-lining operations are completed, the design shown was evolved. It may be seen that the skirt of the concave head is slightly tapered outwardly to match an identical taper formed into the ends of the cylinder. The accurately formed head can then be inserted so that the tapered parts fit together intimately. While held together in a fixture, the assembly is tack-welded to maintain the proper relationship between the parts, and the unit is then moved to the welding station where the welding operation fuses the edges of the cylinder to the skirt of the head. Although the welding heat is intense, the glass coating is not damaged appreciably beyond the margin of the actual weld, and, therefore, undamaged glass remains and extends deeply into the crevice formed by the juxtaposition of the two parts.

Water under pressure could, of course, penetrate into this crevice and reach the weld metal which would not be completely protected by glass. Before assembly of the heads, however, a thin asbestos gasket is attached in such a manner that it is sandwiched into the crevice described. Therefore any water which penetrates deeply into the crevice is trapped by the gasket, and it has been found that corrosion does not occur in this type of joint. It is believed that the asbestos gasket so greatly reduces diffusion of oxygen that corrosion is prevented by lack of oxygen depolarization of the weld metal.

Fig. 8 shows a special automatic furnace which was designed and built for the fusing of the glass to the parts of the water-heater unit. Alloy trays carrying tank parts progress through the furnace in two steps and, upon emerging, are carried by a roller-conveyer system across and back to the starting point. The first zone of this furnace has an air atmosphere and is used for preheating the ware and promoting an oxide layer which is formed on the iron under the dry glass parti-

FIG. 7 CROSS-SECTIONAL VIEW OF GLASS-LINED, AUTOMATIC, STORAGE-TYPE WATER HEATER

FIG. 8 AUTOMATIC CONTROLLED-ATMOSPHERE FURNACE

cles which are not yet fused together. At the proper time, the ware progresses into the second zone of the furnace where air is excluded by means of a continuous supply of oxygen-free gases, mainly nitrogen. In this zone the temperature rapidly rises to the fusion point, and the glass melts together and fuses to the steel in the absence of oxygen. The absence of oxygen greatly minimizes chances for the formation of excessively oxidized points on the iron surface. These points, if formed, may cause imperfections in the glass coating.

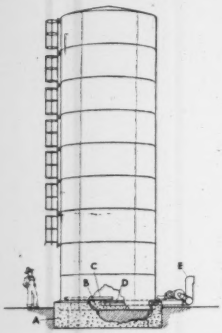


FIG. 9 SCHEMATIC VIEW OF CROP-STORAGE UNIT AND UNLOADING MACHINE

GLASS-COATED CROP-STORAGE UNIT

Glass-lined steel structures, which are known as "Harvestores," have been developed for the storage of silage (Fig. 9). They are 14 ft in diam and 40 ft high and will contain approximately 125 tons of corn silage, or approximately 150 tons of grass silage. Such a unit becomes practical when the number of cows reaches 15 or more, and it is on the 20-cow farm that this unit has created the most interest and has had the widest acceptance.

The glass coating is of value in several ways in a unit of this type. The fermentation converting the crop into silage is accompanied by the production of a considerable amount of lactic acid, the pH of the juices reaching an average value of 4.0. This acid content is quite destructive to most materials of construction, but it has no effect on the glass coating. The steel sheets are also coated with the same glass on the exterior side, and thus complete protection against the elements is also obtained. The silage is unloaded from the bottom, and therefore all of the material has to pass through this unit from top to bottom. The smooth glass affords an ideal surface which provides a minimum of wall friction and allows the material to slide through the unit without any of the serious delays which might be caused if the wall friction were high enough to permit bridging of the material. It is interesting to note that no difficulty in this respect is encountered even in subzero weather, when it might be supposed that the damp silage would freeze to the walls, as it does when some more common materials of construction are used.

Fig. 9 shows the structure with the unloading machine mounted in it. It has been found that the greatest demand for this type of structure calls for a diameter of approximately 14 ft and a height of 40 ft. While there is some demand for smaller units, it is believed that the 14-ft and larger diameters will be the most important sizes. If such a unit were to be fabricated at the factory, transportation would immediately become a serious, if not an impractical, problem. These considerations forced the development of a design which could be assembled readily in the field.

The type of structure adopted is made of sheet-metal plates approximately 5 ft wide and 9 ft long, glass-coated on both sides. Simple overlapped joints appeared to offer the best possibilities, and Figs. 10 and 11 show the method of handling the joints and the intersections of the vertical and horizontal joints. There were also problems due to the height of the structure and the apparent necessity of workmen functioning at least part of the time 40 ft above the ground. After considerable engineering and field work, a method of erection was evolved which permits practically all of the work to be done on the ground.

In order to conserve steel and reduce costs, the thickness of the sheet metal is progressively reduced from bottom to top. Because of the possibility of high vertical loads in the wall,

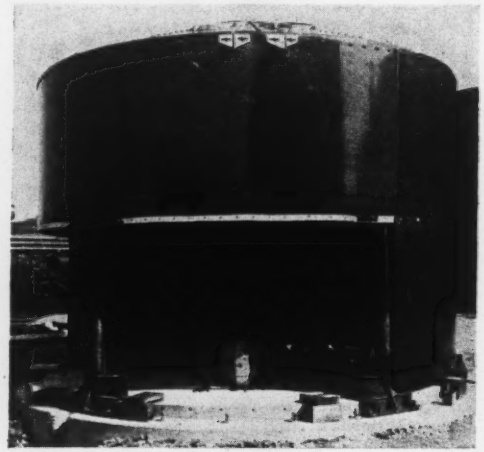


FIG. 10 VIEW OF ROOF, TOP SECTION, AND PART OF THE SECOND SECTION

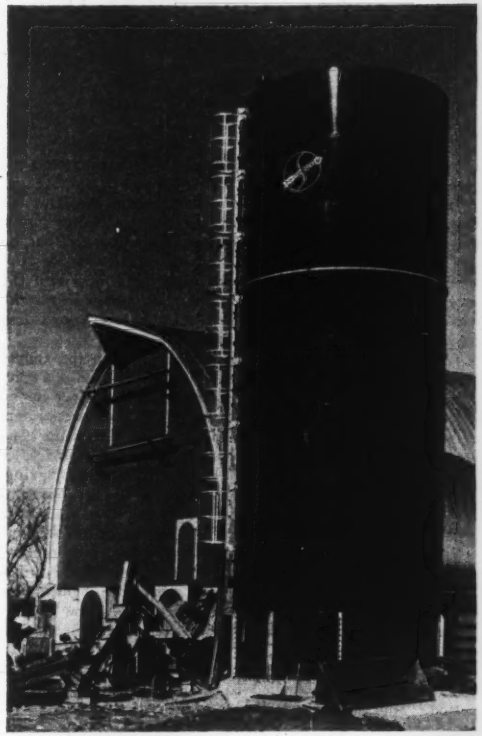


FIG. 11 TYPICAL VIEW OF A COMPLETED HARVESTORE UNIT

the bottom ring section is made of $^3/_{16}$-in-thick steel. This is followed by a ring of $^1/_8$-in-thick steel. Above this are three rings of $^3/_{32}$-in. material, and the remainder of the structure is made of $^1/_{16}$-in-thick material.

Fig. 11 is a view of a recently completed unit as erected on a farm in northern Illinois. The filling operation shown in this picture is typical in that the material is being blown through a vertical pipe into the top of the structure. As mentioned before, the structure was developed primarily for the storage of all of those materials which make good silage. Actually, in this view, the operation is that of filling the structure with shelled corn. This use of the unit is still in the field-test stage. Results have been favorable, thus far.

Fig. 12 is a schematic view of the structure indicating that various crops in any amount may be placed into the unit at any time without loss by mold and similar deterioration. This greatly increases the usefulness of the unit throughout the year, and the oldest material is automatically taken out first.

Fig. 13 is an artist's conception of a processing plant in which three of these units are used for storage of raw materials and for the process. In this type of design the necessary floor space is arranged in a triangular fashion and is enclosed by the glass-coated-steel walls and roof. Such a unit was actually designed and built for the Frazer Products Corporation. This unit is a pilot plant for the Frazer process of converting animal and vegetable waste materials into compost. Compost is an organic type of fertilizer which has great value in rebuilding the original fertility of the soil.

CONCLUSIONS

By means of the foregoing descriptive material, it is hoped that the versatility and special attributes of glass-coated steel have been brought to the reader's attention in a manner that will lead to the helpful solution of other corrosion problems which may be completely remote from those used here as examples.

ACKNOWLEDGMENT

The author acknowledges with thanks the release of data and material granted by the A. O. Smith Corporation.

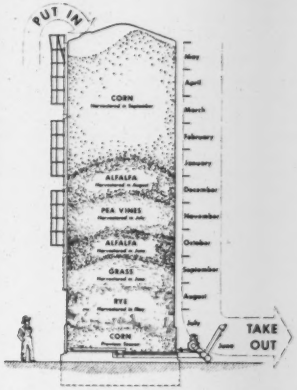


FIG. 12 SCHEMATIC VIEW SHOWING USE OF THE STORAGE UNIT THROUGHOUT THE YEAR

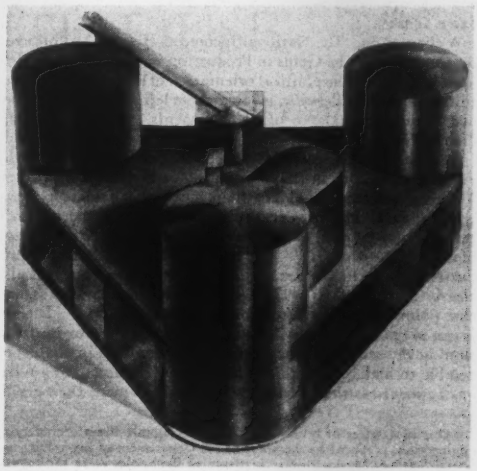


FIG. 13 SPECIAL PROCESS PLANT CONSTRUCTED ENTIRELY OF GLASS-COATED STEEL

NATIONAL INCOME and ECONOMIC POLICY[1]

By ROBERT L. BISHOP

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

OF all the major parts of the study of economics, probably the one of greatest practical importance to the businessman and the perceptive layman is that centering in the concept of national income. George Soule (pronounced "sole") would state this much more strongly. To him economics has finally come of age as a science, no less, now that our economic fortunes can be analyzed in terms of the statistics of national income. Thus, his "Introduction to Economic Science,"[2] rather less broad in scope than the title might imply, is really an introduction to the economics of national income—what it is, how it has behaved, and how its future course can be influenced in the national interest.

If Soule exaggerates the triumphs of national-income analysis and the degree of progress registered over that earlier day "when economics was more a philosophy than a science," this is a relatively slight defect in an otherwise excellent little volume. The author, trained both as a journalist and as an economist, can write both simply and reliably about topics that are admittedly not easy to master. Never patronizing his readers, he nevertheless summarizes clearly, briefly, and with only a necessary minimum of technical terms the recent developments that have contributed to the current importance of the national-income accounts as tools of economic analysis and policy.

Soule describes those accounts themselves in a chapter called "Keeping Books for All the People." From one point of view, national income is simply the sum of incomes earned by all the people; from another, it is the aggregate value of all that they produce. After first explaining this fundamental identity, Soule goes on to discuss the complications raised by taxes, depreciation, corporate saving, and the like. As a result, the reader who had long been mystified by such concepts as gross and net national product has a good chance of having the light dawn at last.

A chapter on "The National Income as History" is followed by another on "The Gains in Production"—as revealed by that history. While the political orientation of the author, a former editor of the *New Republic*, is somewhere left of center, this does not disturb the balance of his judgments. He examines the distribution of the American national income, only to conclude (p. 47) that "while it would be socially desirable to reduce the extreme inequality in the distribution of income, any progress in this direction would not help much to alleviate poverty without large increases in the total product of the nation." In other words (p. 43), "the main objective must be production of more to be divided." The remarkable increases in our productivity since 1900 are statistically summarized; but it is also clearly recognized (p. 47), "We are nowhere near the saturation point of people's desire for goods and services." Later it is stated (p. 59), "Sometimes people worry about 'overproduction' in the sense that they believe we can make, or shall soon be able to make, more things than people want . . . . What has happened is that at times more has been made than people in general were able to buy, which is a different matter altogether."

This observation leads into the next chapter on the "Ups and Downs of Business." It is not Soule's way to plunge into a pet theory to "explain" these business fluctuations; rather, he first merely summarizes what we know, factually and descriptively, about them. But he is intensely concerned with the problem of controlling such ups and downs; and he sees in the nation's Economic Budget, which occupies the entire next chapter, the principal tool for that purpose.

This budget is described as it has appeared in the annual "Economic Report of the President." As the record of a completed year, it shows the net flows of purchasing power among consumers, business, and government—with an additional item to account for our net international dealings. Thus, in 1946, consumers had disposable income (in billions) of 158.4, of which they spent 143.7—leaving 14.8 of personal saving. The government likewise "saved" during that year, having a cash surplus of 1.3. Now the crucial point is that the sum of consumer and government saving (16.1) must be matched exactly by an equal and opposite excess of expenditures over receipts elsewhere in the economy. Business contributed no less than 11.3 toward this—in the form of gross investment in new construction, equipment, and inventories of 24.6 less its own retained profits and reserves of 13.3. Net foreign investment of 4.8 made up the balance.

The Economic Budget becomes a tool for the control of national income when applied to an immediately prospective period. Soule leaves himself open to the criticism of not allowing sufficiently for the awesome difficulties of forecasting; but, in principle at least, he is perfectly correct in emphasizing that if there are changes in, say, consumer saving or business investment or government spending, there *must* be compensating changes elsewhere—*with national income going up or down to bring about the appropriate adjustment*. Thus, if business spending on investment should decline, as at the end of a postwar restocking period, another type of spending might happen to increase just enough to take its place; but if not, national income declines. How far? It falls off until it just equals the total spending that consumers, business, and government are willing to continue to do. As Soule puts it (p. 85), "The great value of the Nation's Economic Budget is that it makes possible estimates of such possibilities *before they happen*. Thus it is an instrument which can be used to forestall either inflation or unemployment if we understand it properly and will consent to take the appropriate action."

It is well worth emphasizing, as Soule does in this last sentence, that we must be on our guard against "either inflation or unemployment." These twin evils are essentially opposites, the one the consequence of too much total spending and the other the consequence of too little. Writing in 1948, Soule was primarily concerned about the danger of an eventual postwar depression. With the intensification of the Korean crisis, we see now that this was optimistic. Yet, even as we look forward wistfully to that day when we can again fear merely depression, we should not think that Soule's lessons are thereby rendered even temporarily obsolete; for they are fully as applicable to the inflationary problems of rearmament. The com-

(*Continued on page 120*)

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] New York, The Viking Press, 1948, $2.50; pp. 5–154.

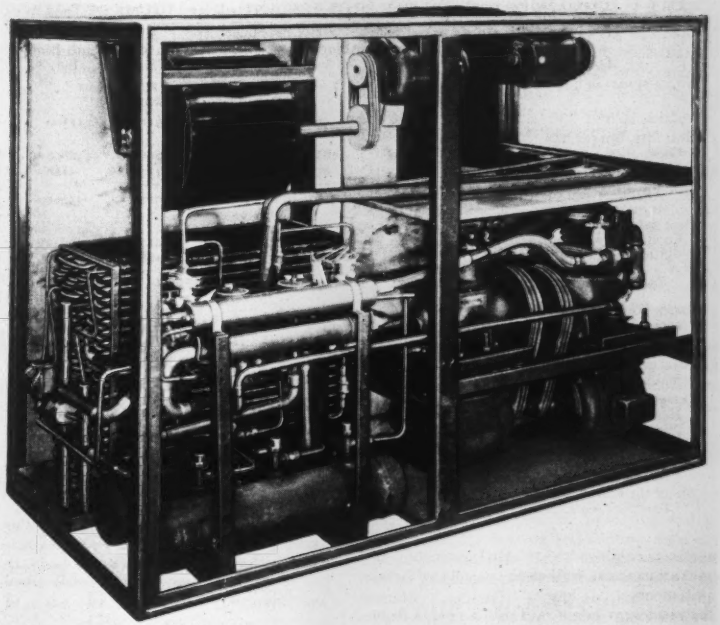


FIG. 1 SELF-CONTAINED HEAT-PUMP UNIT

HEAT-PUMP INSTALLATIONS *for* RESIDENTIAL USE

Operating and Performance Characteristics of Five Units in Different Locations Using Air as the Heat Source

By E. R. AMBROSE

AIR CONDITIONING ENGINEER, AMERICAN GAS AND ELECTRIC SERVICE CORPORATION, NEW YORK, N. Y.

DURING the latter part of 1948, and early part of 1949, five heat-pump units were installed in newly constructed residences under the sponsorship of the Appalachian Electric Power Company, Indiana & Michigan Electric Company, Kentucky and West Virginia Power Company, Inc., The Ohio Power Company, and Wheeling Electric Company, all part of the American Gas and Electric Company system.

Each installation was made in co-operation with the home owner, his architect, and the York Corporation, in order to acquire a better understanding of the operating characteristics, cost, and practicability of residential heat pumps in the areas served by these affiliate companies when using air as the heat source and heat sink.

The five residential heat-pump installations are located in Abingdon, Va., Coshocton, Ohio, Kingsport, Tenn., Roanoke, Va., and South Bend, Ind. These different locations were chosen purposely in order to obtain maximum variation in design requirements and to thoroughly test the units under radically different climatic conditions. The five residences vary widely as to the type and kind of construction, volume of space,

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TABLE 1 SUMMARY OF DATA ON FIVE PILOT RESIDENTIAL HEAT-PUMP INSTALLATIONS

Location	Kingsport, Tenn.	Abingdon, Va.	Roanoke, Va.	Coshocton, Ohio	South Bend, Ind.
No. of stories in house	1½	1	2 with basement	1 with basement	1
Volume, cu ft[a]	20710	14670	13450[b]	19114[b]	11500
Heat loss, Btu per hr:					
Conduction	29650	28336	24681	47968	38808
Infiltration	10350	8540	6200	11300	5860
Total	40000	36876	30881	59268	44668
Heat gain, Btu per hr:					
Conduction and sun effect	30666	19262	14466	14241	19949
Infiltration	4260	3515	2550	4680	2405
Total	34926	22777	17016	18921	22354
Ratio, window area to total wall area, per cent	13.1	12.3	13.1	30.5	21.0
Heat loss, Btu per hr per 1000 cu ft.	1940	2510	2300	2730	3880
Total number of degree-days in normal heating season	3885	3980	4075	5535	6202
Design temperatures:					
Heating	In all cases, 0 F outside, 70 F inside				
Cooling	In all cases, 95 F dry bulb, 75 F wet bulb outside; 80 F dry bulb, 67 F wet bulb inside				

[a] As represented by the outside dimensions for the area and the underside of the floor joists to the top of the ceiling as the height.
[b] Basement not included.

and the distribution system employed.[1,2] Table 1 gives some of the important design variations as well as the calculated heating and cooling requirements.

The volume of the residences given in Table 1 ranges from 11,500 to 20,710 cu ft and includes a two-story structure with a basement, a one and one-half story with first floor slightly above ground, a one-story with basement, a one-story with floor slightly above ground, and a one-story with concrete slab directly on the ground.

THE HEAT-PUMP UNITS

Fig. 1 shows one of the self-contained heat-pump units with the front and side covers removed. At Kingsport, Roanoke, Coshocton, outdoor air is used both as a heat source and as a heat sink. At Abingdon, water and outdoor air are the heat sources, and outdoor air is the heat sink. At South Bend, the earth and the outdoor air are the heat sources, and outdoor air is the heat sink. All of the systems employ air to supply heating and cooling to the conditioned space.

The packaged heat pumps were manufactured by the York Corporation, York, Pa., and are 78 in. long × 60 in. high × 40 in. deep. The units contain two entirely separate F-22 refrigerant circuits, each with its own refrigerating compressor, heat-absorbing and heat-dissipating surfaces, valves, and connecting piping. For the dual heat-source designs, one refrigerant circuit is used for each heat source. In all five systems the conditioned air circulated to the space by means of one fan is common to both refrigerant circuits. In the system using air exclusively as the heat source, the outdoor air also circulated by means of one fan is similarly common to the two refrigerant circuits.

Table 2 gives some design information on one of the heat-pump units using air as the heat source and air as the heat sink. The nominal 3-hp compressor is sized to operate without excessive motor overloading during the heating cycle at the higher outdoor temperatures, and the nominal 2-hp compressor is sized for the lower outdoor temperatures (26 F and below). The 3-hp system is used during both the heating and cooling cycle, while the 2-hp system is used only during the heating cycle. In order to prevent excessive operating pressures during the cooling cycle, it may be seen from Table 2 that additional surface is used for the outdoor-air coil and less surface for the conditioner coil of the 3-hp system.

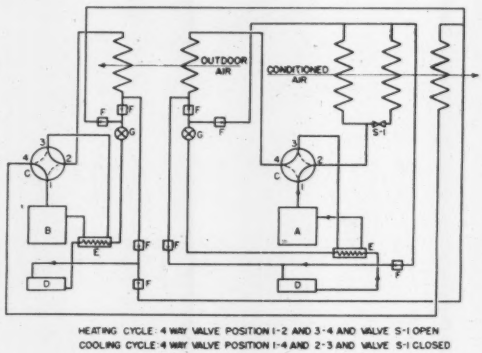

FIG. 2 SCHEMATIC REFRIGERANT PIPING DIAGRAM FOR TWO-CIRCUIT HEAT-PUMP UNIT

(Legend: A, 3-hp compressor; B, 2-hp compressor; C, 4-way valve; D, liquid receiver; E, liquid-gas heat exchanger; F, check valves; G, thermostatic expansion valves)

REFRIGERANT SCHEMATIC FLOW DIAGRAM

The 2-hp and 3-hp refrigerant schematic flow diagram of one of the heat-pump units, using air as the heat source, is shown in Fig. 2. It can be noticed that the air from the conditioned

[1] "The Residential Heat Pump in Various Climates for Summer and Winter Air Conditioning," by P. Sporn and E. R. Ambrose, *Heating and Ventilating*, vol. 46, May, 1949, pp. 79–86.
[2] "Heat Pump Undergoing Tests in Five Houses," by P. Sporn and E. R. Ambrose, *Architectural Record*, vol. 105, May, 1949, pp. 140–144.

TABLE 2 SOME DESIGN INFORMATION ON ONE HEAT-PUMP UNIT USING AIR AS HEAT SOURCE AND AIR AS HEAT SINK

F-22 refrigerant compressors, nominal hp	2 and 3
Outdoor-air fan:	
Horsepower	1/2
Revolutions per minute	750
Conditioner fan:	
Horsepower	3/4
Revolutions per minute	1140
Outdoor-air coil:	
Air flow, cfm	2500
Frontal area, sq ft	6
Rows deep, 3 hp/2 hp	12/4
Fin spacing, per in	3
Face velocity, fpm	410
Conditioner coil (heating):	
Air flow, cfm	1500
Frontal area, sq ft	4
Rows deep—3 hp/2 hp	8/4
Fin spacing, per in	6
Face velocity, fpm	375
Conditioner coil (cooling):	
Air flow, cfm	1500
Frontal area, sq ft	4
Rows deep—3 hp	4
Fin spacing, per in	6
Face velocity, fpm	375

space and the outdoor air first pass over the 3-hp surface, then over the 2-hp. This sequence causes the 2-hp system to operate at a slightly higher condensing temperature and a lower evaporating temperature than the 3-hp system. The 4-way valve is used to change the direction of the refrigerant flow. During the heating cycle the valve is positioned to first direct the refrigerant gas from the compressor to the conditioner coil, while during the cooling cycle, or defrosting cycle, the position of the valve is changed to first direct the refrigerant from the compressor to the outdoor-air coil.

CONTROL

The operation of the unit is under control of a room thermostat. A manual selector switch permits intermittent or continuous operation of the conditioner fan. The description given is for a unit using air as the heat source and having the conditioner fan on intermittent operation. When the room thermostat calls for heating, the 3-hp compressor, the outdoor-air fan and the conditioner fan will start and operate as long as necessary to satisfy the requirements. As the outside temperature drops, the suction pressure of the 3-hp system will drop proportionally. When the suction pressure falls to a value caused by an outdoor temperature of approximately 26 F, a pressure switch will start the 2-hp machine. At these lower outdoor temperatures, the 2-hp system cycles in response to the heating thermostat, and the 3-hp operates continuously. Need for defrosting is indicated by a switch sensitive to the pressure drop across the outdoor coil. When the switch calls for defrosting, the position of the 4-way valve is changed to first direct the high-temperature high-pressure refrigerant gas from the compressor to the outdoor coil. A time-delay relay in the defrosting circuit governs the time of this cycle.

When the room thermostat calls for cooling, the 3-hp compressor, the outdoor-air fan, and the conditioner fan operate, and the 4-way valve is positioned to first direct the refrigerant from the compressor to the outdoor coil. The 2-hp system does not operate during the cooling cycle.

PERFORMANCE

Testing instruments were installed on each of the five systems to obtain all possible operating and performance data during both the heating and cooling season. The testing instruments shown in Fig. 3 include compressor-discharge and suction-pressure recorders, outdoor air temperature - relative humidity recorder, supply-air and return-air temperature recorders, as well as ten electric meters to record the electric-energy consumption and load characteristics of all equipment.

The expected heating output and coefficient of performance at various outdoor temperatures of one of the packaged heat-pump units, using air as the heat source, is shown in Fig. 4.

Table 3 shows the results of a field test made on one of the units during the heating cycle using air as the heat source. Test No. 1 covers the operation of both the 2 and 3-hp units at an outdoor temperature of 18 F, and test No. 2 covers the

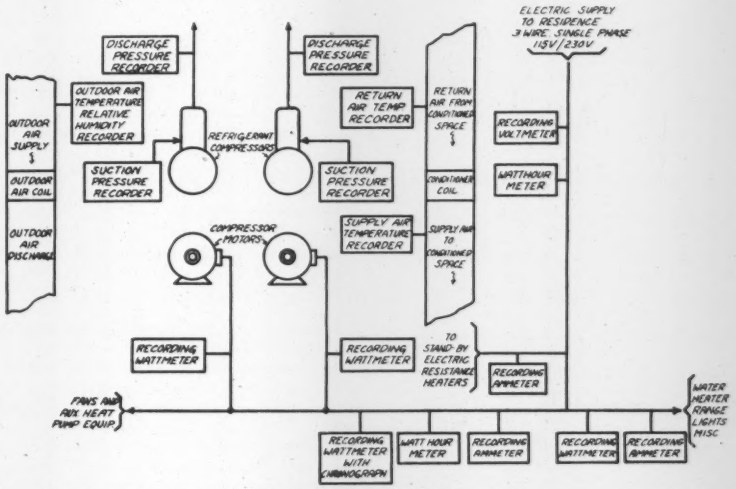

FIG. 3 TYPICAL SCHEMATIC DIAGRAM SHOWING TESTING EQUIPMENT FOR RESIDENTIAL HEAT-PUMP UNITS

TABLE 3 PERFORMANCE OF HEAT-PUMP UNIT USING AIR AS HEAT SOURCE

	Test no. 1[a]	Test no. 2[b]
Conditioner coil:		
Air flow, cfm	1500	1500
Entering air, deg F	70	70
Leaving air, deg F	97.5	91.5
Outdoor coil:		
Air flow, cfm	2500	2500
Entering air, deg F	18	35
Leaving air, deg F	9.1	27.7
3-Hp compressor:		
Suction pressure, psig	30	48
Evaporating temperature, deg F	6.7	25
Discharge pressure, psig	213	198
Condensing temperature, deg F	105	100
2-Hp compressor:		
Suction pressure, psig	25	...
Evaporating temperature, deg F	1.0	...
Discharge pressure, psig	229	...
Condensing temperature, deg F	110	
Electric consumption (watts):		
3-Hp compressor	2330	2580
2-Hp compressor	1940	...
3/4-Hp conditioner fan	900	900
1/2-Hp outdoor-air fan	712	716
Total	5882	4196
Capacity:		
Refrigerating effect, Btu per hr	24000	20000
Heating output, Btu per hr	44000	34300
Coefficient of performance	2.2	2.4

[a] Test No. 1, 3 and 2-hp systems.
[b] Test No. 2, 3 hp system only.

operation of the 3-hp unit only at an outdoor temperature of 35 F. These test values are slightly lower than the expected heating performance given in Fig. 4. The difference may be caused partly by the transfer of heat between the conditioner air circuit and the outdoor air circuit, partly by losses in the 4-way valve, and partly due to the difficulty of obtaining accurate field-test results. It is hoped that closer checks will be obtained when all the data have been analyzed and correlated.

An electric-resistance heater having a 15-kw nominal rating was installed in each of the five heat-pump systems in order to check the calculated heating requirements of the space, to act as a stand-by in case of failure of the heat-pump equipment, and

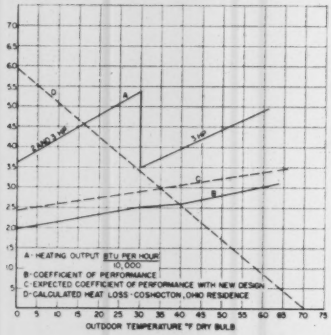
A - HEATING OUTPUT BTU PER HOUR
10,000
B - COEFFICIENT OF PERFORMANCE
C - EXPECTED COEFFICIENT OF PERFORMANCE WITH NEW DESIGN
D - CALCULATED HEAT LOSS - COSHOCTON, OHIO RESIDENCE
OUTDOOR TEMPERATURE °F DRY BULB

FIG. 4 EXPECTED HEATING OUTPUT AND COEFFICIENT OF PERFORMANCE AT VARIOUS OUTDOOR TEMPERATURES OF PACKAGE HEAT-PUMP UNIT USING AIR AS HEAT SOURCE

to serve as a booster whenever required. In order to check the calculated heat requirements, electric-resistance heaters were used one day each week to supply the required heating in place of the heat-pump unit in each of the five residences. The electric energy used at various outdoor temperatures by the resistance heater in the Abingdon, Va., system is shown in Fig. 5.

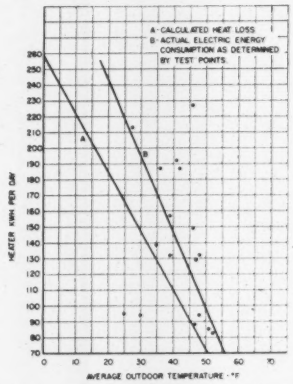
A - CALCULATED HEAT LOSS
B - ACTUAL ELECTRIC ENERGY CONSUMPTION AS DETERMINED BY TEST POINTS
HEATER KWH PER DAY
AVERAGE OUTDOOR TEMPERATURE - °F

FIG. 5 ELECTRIC-ENERGY CONSUMPTION AT VARIOUS OUTDOOR TEMPERATURES USING RESISTANCE HEATING FOR ABINGDON, VA., RESIDENCE

It may be noted that the electric-energy consumption for days with the same outdoor temperature varies considerably, and also the average of the test points is slightly above the calculated heat loss. Some of the variations in energy consumption for days with the same outdoor temperature is probably due to changes in wind velocity and to the different amount of heating effect obtained from the sun. Maintaining higher indoor temperatures than the 70 F used as a basis for design is one reason why the actual consumption is higher than the calculated. It is hoped that further analyses of all the test data will show other reasons for the differences between actual and expected performance.

Table 4 is a tabulation of some of the important design information on the five heat-pump installations. Column 7 of this tabulation gives the yearly electric-energy consumption during the heating and cooling cycle. Column 8 gives the actual degree-days during the heating season for the five installations. The degree-days for Coshocton, Roanoke, and Kingsport were lower, and South Bend and Abingdon were higher than the normal given in Table 1. Column 9 gives the expected kilowatt-hours of heating based upon the calculated heat loss, the average outdoor temperature for the season, and for an average indoor temperature of 72 F when using an average coefficient of performance of 2.5 for the heat pump.

OPERATION AND MAINTENANCE

During the first few months of operation, considerable difficulties were experienced with compressor-belt breakage, and with failure of the 4-way valve. The excessive belt breakage was caused by insufficient contact between the belt and the driver sheave owing to the short compressor-motor center distance; also the type and design of belt was not suitable for the high operating pressures resulting from the use of F-22 refrigerant. These operating difficulties were eliminated by using heavy-duty belts and by changing to larger-diameter sheaves to increase the arc of contact.

TABLE 4 DESIGN INFORMATION ON HEAT-PUMP INSTALLATIONS

1 Classification	2 Installation date	3 Volume[a] cu ft	4 Construction	5 Heat source	6 Equipment	7 Electric-energy consumption, kwhr: Heating	7 Electric-energy consumption, kwhr: Cooling	8 Degree-days	9 Estimated kwhr, heating cycle
1 Story residence, O. H. Stevning, Coshocton, Ohio	1949	19114[b]	Storm sash and double fixed windows; 1-in. sidewall insulation; 4-in. ceiling insulation	Air	2 and 3-hp compressors; 3/4-hp outdoor-air fan; 3/4-hp conditioner fan; 1/4-hp circulating pump	22905	3326	5055	16550
2 Story residence, E. B. Setzler, Roanoke, Va.	1948	13450[b]	Storm windows; 3 1/2-in. sidewall insulation; 3 1/2-in. ceiling insulation	Air	one 2 and one 3-hp compressor; 1/2-hp outdoor-air fan; 3/4-hp conditioner fan	10650	2715	3874	7170
1 Story residence, Virgil Place, South Bend, Ind.	1949	11500	Thermopane windows; 2-in. sidewall insulation; 4-in. ceiling insulation	Air and ground	one 2 and one 3-hp compressor; 1/2-hp outdoor-air fan; 1/3-hp circulating pump; 3/4-hp conditioner fan	18179	2612	6422	15000
1 1/2 Story residence, D. W. Moulton, Kingsport, Tenn.	1949	20710	Storm sash; 3 1/2-in. sidewall insulation; 4-in. ceiling insulation; 2-in. floor insulation	Air	one 2 and one 3-hp compressor; 1/2-hp outdoor-air fan; 3/4-hp conditioner fan	19259	4179	3394	8620
1 Story residence, J. D. Moore, Abingdon, Va.	1949	14670	Storm windows; 4-in. sidewall insulation; 4-in. ceiling insulation; 2-in. floor insulation	Air and water	one 2 and one 3-hp compressor; 1/2-hp outdoor-air fan; 3/4-hp conditioner fan; 3-hp deep-well pump[c]	10386	3060	4182	9020

[a] As represented by outside dimensions are area and underside of floor joist to top of ceiling as height.
[b] Basement excluded.
[c] Deep-well pump used also for domestic supply.

The disks of the 4-way valve and the erratic operation experienced in changing from one cycle to another caused some difficulty. The valve operated satisfactorily after a different material was used for the disks, and minor design changes were made by the manufacturer, and after the external pressure taps were connected as close as possible to the compressor.

The air filters, located in the conditioner fan circuit, were too small in area, resulting in an unusually large pressure drop with the accompanying increase in fan horsepower. The trouble was eliminated by increasing the filter area and locating the section remotely from the unit.

Several breakdowns with loss of refrigerant resulted from the splitting of the flexible connection on the compressor high-pressure-discharge line. This failure may have been due to too short a piece of flexible tubing being used, combined with the excessive motion of the compressor caused by the spring mountings.

The defrosting cycle seems to be erratic in operation, causing an unusually large number of defrosting cycles. Table 5 gives the number of defrosting cycles, by months, the total defrosting time in hours, and the kilowatt-hours used for defrosting as a total and as a percentage of the kilowatt-hours used for heating. The defrosting time was set at 7 min per cycle, the thought being that more frequent defrosting of shorter duration would not be so objectionable to the occupants. Results indicate that perhaps larger accumulations of frost could be tolerated and perhaps an even shorter defrosting period could be used. This is a difficult thing to determine, however, and must by necessity be a field adjustment.

TABLE 5 DEFROSTING CYCLE OF PACKAGE HEAT-PUMP UNITS

	Abingdon, Va.	Kingsport, Tenn.	Coshocton, Ohio	South Bend, Ind.
1949				
October	7	...	...[a]	3
November	184	185	...[a]	65
December	91	282	3	66
1950				
January	33	94	110	80
February	74	33	249	143
March	113	17	362	101
April	47	15	116	42
Total defrosting time, hr	64	73	98	60
Kwhr used for defrosting	256	310	392	280
Per cent of total kwhr used for heating	2.4	1.6	1.3	1.5

[a] Not complete—no operation during October and November, 1949.

CONCLUSION

The annual kilowatt-hours for heating and cooling were about 20 to 30 per cent greater than was expected on the basis of calculated performance. Only part of this difference can now be accounted for, but it is hoped that a satisfactory explanation can be given for all of it after the analyses are completed. The storm windows were not installed in the Kingsport residence until very late in the heating season, and the supply ducts exposed in the basement and garage of the Roanoke system are uninsulated. This is probably the main reason for the actual kilowatt-hours being larger than expected for these two installations. It was found that the expansion valve was not functioning correctly at the lower outdoor temperature on all units, and it appears that air leakage and heat transfer between the conditioner and outdoor-coil circuit was taking place, which contributes to the capacity reduction as indicated in Table 3.

During the defrosting cycles the five heat pumps used the air going to the conditioned space as the source of heat. In no case did the occupants complain of cold air or drafts during this cycle. In fact, it was difficult to detect from the occupied space when the unit was on the defrosting cycle. This may be due to the relatively short time (7 min) employed for the defrosting cycle.

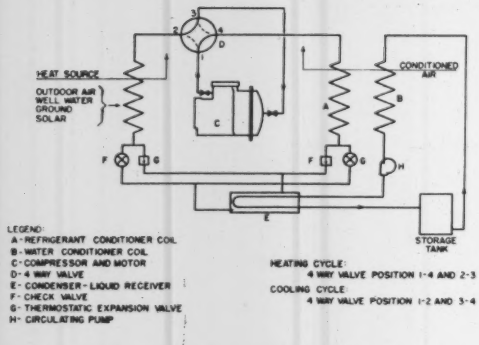

FIG. 6 STORAGE HEAT-PUMP SYSTEM FOR HEATING AND COOLING BY CHANGING REFRIGERANT FLOW

(Air, water, solar energy or the earth is used as heat source.)

All of the test data taken during the year have not as yet been analyzed completely but the results so far indicate that considerable design improvements can be made in the unit. Extensive design changes are planned for all five of the units. The changes on the Kingsport, Roanoke, and Coshocton systems already have been made, and those on the Abingdon and South Bend units will be completed by early fall.

Fig. 6 shows the flow diagram of the Roanoke and Coshocton redesigned systems. The flow diagram of the Kingsport system is similar, except that the storage portion of the cycle was omitted.

A water-storage system was incorporated in the redesign of the Coshocton unit, since the heating requirement exceeded the output at the outdoor temperature below $16^1/_2$ F as shown in Fig. 4. The storage tank will supplement the output of the unit to meet the peak demand during these periods.

In order to get some experience with a storage system using the heat-of-fusion principle, 4700 containers, $2^1/_8$ in. diam × $2^7/_8$ in. long, filled with sodium phosphate dibasic 12 H_2O were incorporated in the Roanoke system. The small containers are located in two 275-gal tanks. Water is circulated over the containers and through the condenser-liquid receiver and water-conditioner coil in a closed circuit, as illustrated in Fig. 6. The compressor was reduced from 5 to 3 hp, since studies indicate that a 3-hp compressor with storage will furnish the necessary heating.

In addition to adding storage, other changes in the redesign of the unit include changes in the distributor header on the outdoor and conditioner coils, the addition of an expansion valve for each coil, the relocation of the coils to enable the refrigerant to drain to the liquid receiver, as well as to obtain better air circulation with less pressure drop, and the number of check valves was reduced from four to two per system. The conditioner air circuit was changed so that return air would not pass through the compressor compartment during the cooling cycle, and the 4-way valves were relocated from outdoor air to conditioned air. It is believed that the changes will show considerable improvement in the operation of the system, and at the same time increase the coefficient of performance as shown in Fig. 4.

On the whole, it is felt that after some of the earlier difficulties were eliminated, the unit made a very satisfactory and creditable showing.

The design changes described were made because it was thought that the operation and performance of the units could be improved. It was demonstrated by the field tests that a heat pump using air as a heat source could satisfactorily heat a residence in the areas selected. Results also indicate that incorporating storage in the design has very definite and desirable advantages. It appears very likely that the storage type of system will be found to be more practical for the areas under consideration when using air as the heat source.

National Income and Economic Policy

(*Continued from page 114*)

pensatory rules now call for higher taxes, tighter credit controls, and the elimination of nonessential spending just as surely as an incipient depression would call for the opposite.

It should be noticed that the spending whose changes are crucial for this analysis represents a flow per unit of time. This raises the question of how that spending flow is related to the quantity of money, which exists at any instant but which also changes over time. Briefly, of course, the spending represents a quantity of money times some factor of turnover or velocity; but that merely opens the subject of the many subtle relationships between changes in the quantity of money and changes in the volume of spending. Soule explains part of the problem very well in his chapter on "How Money Appears and Disappears." At the same time, however, his discussion is at least partially misleading; for he writes as though there is some inevitable connection between changes in spending and changes in the quantity of money. The truth is that we can have major changes in rates of spending without any change whatever in the quantity of money; or conversely, we can have great changes in the quantity of money without anything like proportional changes in total spending. That Soule fails to illuminate these possibilities is an undoubted shortcoming, but perhaps not too serious a one in the light of the fact that often spending and the quantity of money do change more or less together.

Elsewhere in his book, Soule pays his respects expositionally and critically to the theoretical contributions of the late Lord Keynes; he outlines the administrative machinery set up to plan for high-level employment under the Employment Act of 1946; and he concludes his book with a chapter on international implications.

FREE nations of the world hold a 3-to-1 advantage in coal reserves over countries encompassed by the "iron curtain," it is revealed by the Bituminous Coal Institute, Washington, D. C.

The Institute's figures, taken from U. S. Bureau of Mines reports, list the world "probable coal" total at 6964 billion tons, with almost half (3180 billion tons) ascribed to the United States alone. Canada's share is placed at 898 billion tons.

Russia's own reserve supply of coal is set at 1367 billion tons, which—when augmented by the stocks in Red China, Poland, and Czechoslovakia—gives the Kremlin a potential store of 1770 billion tons, approximately one quarter of the world supply based on current territorial domination by the USSR. Most of Germany's coal lies outside the Red Zone.

The importance of coal reserves to national subsistence in the years ahead was explained by Dr. Arno C. Fieldner, chief of the Fuels and Explosives Division, U. S. Bureau of Mines, in a recent address. He pointed out that coal, which is the world's major source of energy, will ultimately be the primary source of liquid and gaseous fuels as well as solid fuels.

The Developing Critical SHORTAGE *of* ENGINEERS

By S. C. HOLLISTER

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OUR country is once again obliged to arm in an effort to preserve peace and to prepare for attack if it should come. No thinking person fails to grasp the fact that we are greatly outnumbered and that our chances of survival are dependent upon our ability to out-design, out-develop, out-produce, and out-perform our enemies. At the same time that we are preparing for possible large-scale war, we must maintain, on a more efficient basis than ever before, our civilian functions. Moreover, we must prepare for eventual attack on our cities and on our industries and for the invasion of our homeland.

World War II brought to public attention the extent of the contribution to the war effort of the scientists and engineers. We could not have fought, much less won, that war without the vast equipment planned, developed, built, and operated by engineers. Not only have the engineers provided the country with the laborsaving devices, the means of transportation, communication, production, and distribution in peacetime, but they have also provided the special versions of all these services for war. The engineers design, develop, produce, and operate the ships, the planes, the guns, missiles, rockets, and ammunition, the tanks and armored vehicles, the radio, radar, sonar, loran, and other devices of communication and detection, the vast transportation facilities needed in warfare. They are clearly indispensable.

But we are short of engineers. As we advance in the war preparations the shortage will be greater. As one contemplates the dependence upon engineers in the task before us the seriousness of a shortage in this part of our manpower becomes evident. It comes about because there has been a falling off in enrollments in engineering colleges, largely due to a widely and erroneously held belief that engineers were in oversupply. The shortage will deepen if engineers are drafted or called up as reservists and used in positions for which engineering training and experience are not mandatory.

The accompanying chart presents the essential factors in the outlook for supply of engineering graduates. The lower curve shows the annual output of the engineering colleges of the country for the academic years 1935–1936 to 1950–1951. It shows that from 1942 through 1945, the country, through its mistaken manpower policy, all but stopped the operation of engineering education. That is the reason why industry today is not successful in finding critically needed engineers with 5 to 10 years' experience. They were not produced at the rate they should have been.

Beyond 1950 a dotted line shows the estimated number of graduates to be expected if the schools operated without any withdrawals by Selective Service. It represents the most optimistic production possible, at least until 1954, since all classes graduating up to that year are already enrolled in the colleges.

Since the number of graduates depends upon the number entering the colleges, the curve of freshmen is shown. Again is evident the low enrollment of freshmen of the war years, many of whom were taken out of college for military service. Following the war, the veteran benefits program brought the unprecedented number of 91,000 freshmen into the colleges in the fall of 1946. These did not come direct from the high-school graduations in that year, but represented an accumulation of high-school graduates who, for several years, had not been permitted because of the draft to proceed with college training. Since 1946 the numbers of freshmen have fallen rapidly until in 1950 there are enrolled about 30,000.

Beyond 1950 there is shown a dotted line indicating estimated freshman enrollment. This estimate was made before the Korean War, and was based on normal peacetime expectancies. It is seen that the actual enrollment for 1950 did not reach the estimate, due largely to widespread rumor that the engineering field was oversupplied.

The present situation already shows tightness in all fields and critical shortages in many. Industry has absorbed the last two graduating classes of nearly 50,000 each and is hotly contesting for the 30,000 that will graduate in 1951. Many of the graduates are in ROTC programs and may thus go direct to military service. A large number have draft postponements and will be subject to call in June, if not before. Still others are veterans.

On Aug. 3, 1950, the Secretary of Labor placed all branches of engineering on the list of critical occupations. In all the major branches, the shortage of engineers is becoming progressively more critical, especially in aeronautical, chemical, electrical, and mechanical manufacturing fields. Men with a few years of experience are almost unobtainable.

In normal peacetime it is generally accepted that at least 20,000 graduates are required annually. In the present situation it should be recalled that industry has absorbed 50,000 engineers in each of the last two years; but some of these certainly take the place of those that could not be hired in war years because in those years they were not being produced except in small numbers. Industry, however, does not have all it needs; and the military requirements have not as yet been taken. It thus appears that the minimum annual need is not less than 30,000 engineering graduates with use for many more if they should be available.

How do we obtain not less than 30,000 graduates yearly? First of all, to do so requires an annual input of 60,000 freshmen. This is about double the number entering engineering schools this year. How may twice as many high-school graduates be attracted to engineering schools? Are there that many among the high-school graduates who have an interest in engineering and who, at the same time, have the necessary aptitude and abilities?

The numbers of male and female high-school graduates anticipated are shown at the top of the chart. It appears that between 1950 and 1958 there will be a 10 per cent dip in the numbers graduating so that the range is between 1,250,000 and

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1,130,000. We clearly cannot rely, therefore, upon an increase in output of the high schools to solve the problem.

Except for the war and immediate postwar years, which were abnormal, the numbers entering engineering schools since 1935 range from 2.7 to 3.1 per cent of the total high-school graduating classes. On the basis of an average high-school output of 1,200,000 boys and girls, 5 per cent would be required to produce 60,000 engineering freshmen. This is about 10 per cent of the boys graduating from high school. There is some doubt whether the combined factors of aptitude, ability, and interest would be found in so high a percentage. It seems possible that the 60,000 freshmen shown as needed on the chart may be at or above the available number that can be expected to enter engineering. This brings home the clear fact that there is not, and there cannot be developed, an inexhaustible supply of engineering talent but, instead, the supply is sharply limited.

Nevertheless it is essential that all available avenues of information be used to acquaint the high-school principals, high-school guidance counselors, and the high-school students themselves with the shortage and consequent need of engineers in all categories. It is vital to our security and welfare that such information reach these persons.

What is significant to industry in the picture here set forth? It means that there will not be young replacements for engineering jobs vacated by the calling of reservists or of draftees. There will be only a partial supply of young engineers for new jobs as conversion, retooling, and war production may require. Intercompany pirating will only add to the difficulties of staffing. Robbing the colleges of faculty members for industrial jobs will surely dry up the supply and reduce the quality of training given by the colleges.

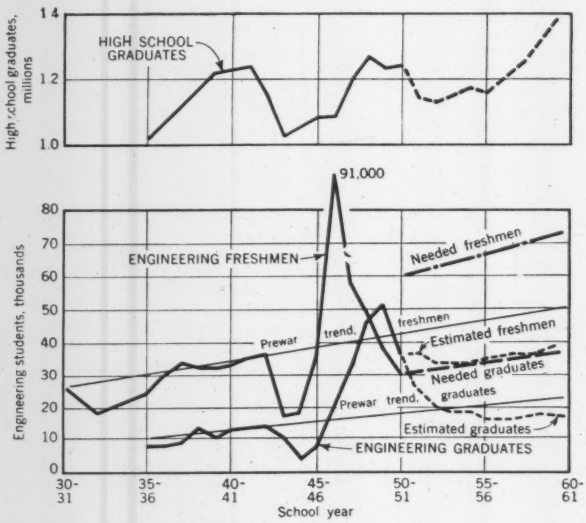
It will be essential for industry to re-examine the functions of the engineering personnel and to make certain that each engineer is being used in the most effective manner possible. No engineer should be used in positions others can occupy as well. Supporting personnel, requiring less training, and experience, should be used to spread as far as possible the effectiveness of each engineer.

Even competent supporting personnel will be tight. It will be necessary to begin in-service training of such personnel and to engage women in so far as possible. The training programs of the last war will need to be re-established. None of these steps can be put off. The organization of industries must be streamlined now.

Government agencies, including the armed forces, must take cognizance of the situation. Plans must be developed whereby the engineering manpower needs of the services and of industry may be so co-ordinated that both will be appropriately served from the limited supply. Industry has the job of supporting the military. To assume that the military needs are paramount or exclusive would be a form of national suicide.

A careful planning for utilization of men with engineering training and experience only in categories where such training and experience are mandatory should be undertaken; although such can probably not be wholly achieved, it is in the interest of the total effort that such an objective be approached as nearly as possible. Sound policies relating to deferment and the calling of reservists must be promulgated with the objective of maintaining a balanced utilization.

It is reported in the technical press that the Russians, in their current five-year plan, are scheduled to have produced 150,000 engineering graduates by the end of 1950. This matches our own output for the same period. During the next five years, however, we will drop by one third unless drastic action is taken to increase the supply of engineering freshmen and to continue the training operation in full force.



OUTLOOK FOR ENGINEERING GRADUATES

(Actual and estimated enrollment by U. S. Office of Education. Needed freshmen and graduates estimated by S. C. Hollister.)

Some DESIGN ASPECTS *of* METAL-POWDER PARTS

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INTRODUCTION

TO appreciate the problems encountered in designing for powder-metal parts, it is necessary to know something of the process itself. The production of parts by the powder-metallurgy process is not large at present as compared to sand-casting, die-casting, stamping, or screw-machining, but for the past few years has been steadily growing. Iron, brass, tin, and copper powders are used in the greatest tonnages, excluding the various carbides, and the use of tungsten for lamp filaments and electrical contacts. These powders are made by at least five different methods—by reduction of oxide, by electrolysis, by disintegration, by atomization, or by the carbonyl method. At present there are approximately 25 companies engaged in their production.

For purposes of this discussion, a "metal powder" may be said to consist of finely divided metal, all of which will pass through a 60-mesh screen, and a substantial portion of which will pass through a 325-mesh screen. It can be spherical, acicular, dendritic, flakelike, or irregular in shape, or a combination of these.

"Powder metallurgy" is the art of making objects by compressing metal powders, with or without the addition of nonmetallic powders, usually with subsequent heat-treatment.

The process is primarily a large-quantity high-speed production method. Die costs are relatively high, and as a result, small production runs usually are not economical. In general, quantities should be in excess of 10,000 parts to amortize the dies.

PRODUCING POWDERS BY ATOMIZATION

Since 1938, the author's company has been studying methods of producing and utilizing nonferrous powders, and has a plant for producing them from those metals amenable to atomization. Basically, this process is quite simple. Metal is melted in a conventional manner, raised to the proper temperature, and poured in a thin stream. High-velocity steam, water, air, or other gas is directed against this stream and the metal is literally blown into a powder. This product is dried, if necessary, screened and analyzed, and is then ready for use.

Needless to say, the preceding description represents an oversimplification of a rather difficult procedure. However, brass, bronze, nickel, silver, copper, and zinc powders are produced by this process and fall into two distinct classes:

1 Those of spherical particle shape, Fig. 1
2 Those of irregular particle shape, Fig. 2

Other factors being equal, irregular particles lend themselves better to parts fabrication than those of spherical shape.

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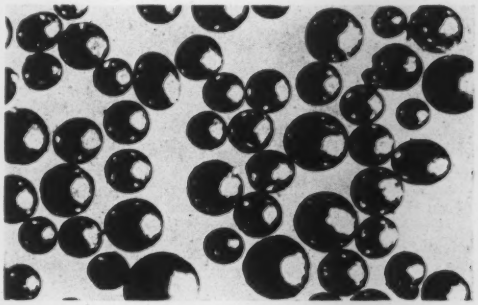

FIG. 1 A TYPICAL SPHERICAL POWDER
(This is a 70–30 brass powder; ×100.)

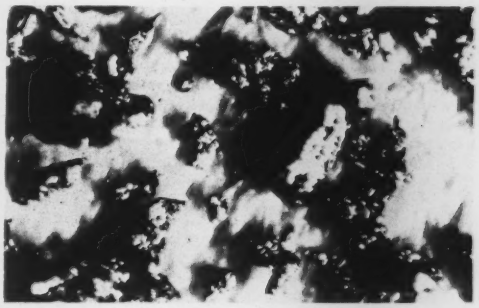

FIG. 2 A TYPICAL IRREGULAR POWDER
(This is a 70–30 brass powder; ×100.)

PARTS-FABRICATION PROCESS

In making parts, metal powder is first mixed with a lubricant, gravity-fed into a die, pressed to the desired shape under 10–50 tons per square inch pressure, ejected, sintered, and sometimes repressed or coined.

Pressing. Although each step of the process is important, design factors are influenced most by the pressing and sintering operations. Pressing consists in applying pressure on the powder either from the top or from both top and bottom. Fig. 3 shows a single punch press which is typical of those used. Such equipment is capable of fairly high production speeds and for both top and bottom-pressure application. Fig. 4 is a multiple-punch rotary press. Because of its very high speed—up to 300 or more compacts per minute—and high die costs, such equipment can be used only on very large production runs.

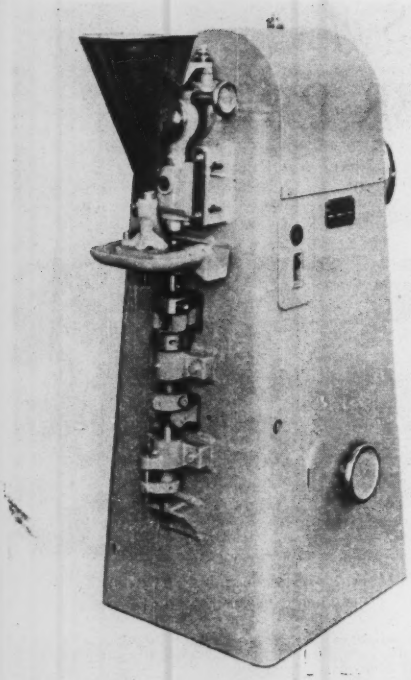

FIG. 3 A SINGLE-PUNCH, TOP AND BOTTOM-ACTION PRESS
(Such equipment can run at speeds in excess of 2000 pressings per hour.)

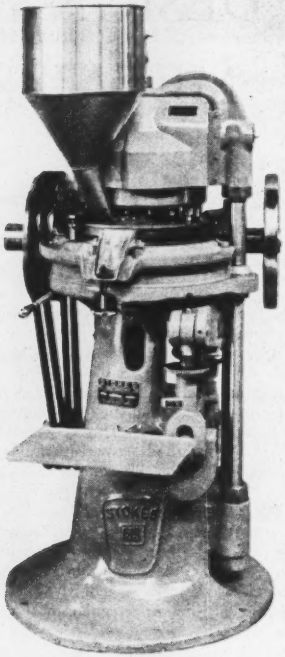

FIG. 4 MULTIPLE-DIE ROTARY PRESS

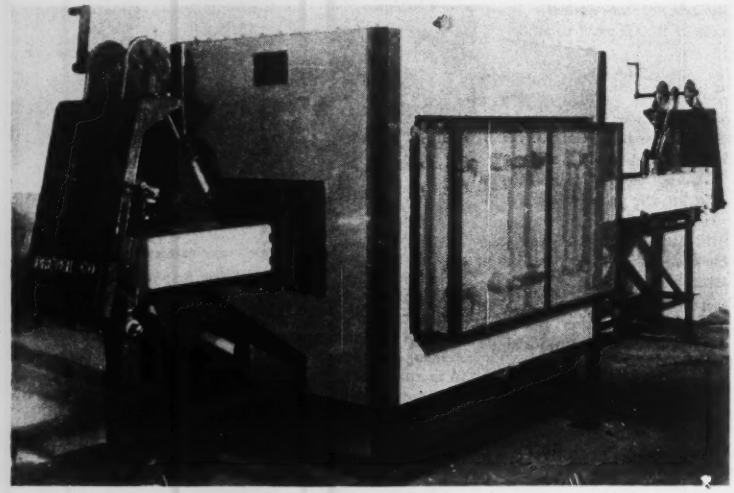

FIG. 5 TYPICAL MODERN SINTERING FURNACE
(For high production, a conveyer-type furnace is frequently used.)

Sintering. In Fig. 5 is shown a typical sintering furnace. These are of various types, some being hand-operated, that is, the charge of pressed parts is loaded and removed by hand, and others being conveyer type. The amount of production to be sintered governs the type of furnace.

Sintering is done in either an inert or reducing atmosphere, and close temperature control is essential. Not only does the sintering temperature affect the mechanical properties of a part, but it also has an effect on the shrinkage or expansion which invariably takes place.

Die Design. One other essential part of the process is the die set itself. Fig. 6 shows a simple four-piece die; an upper punch, lower punch or ejector, core rod,

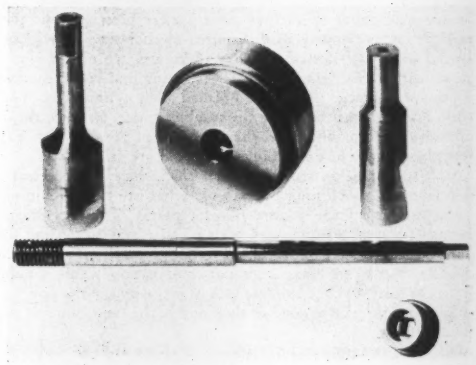

FIG. 6 TYPICAL DIE SET

(Parts shown are, from left to right, ejector, die body, punch, and across the lower portion, the core rod. The part formed in this die set is shown in the lower center.)

and the die body. For ordinary production runs tool-steel dies are commonly used, but for very large runs carboloy die sets may be utilized. Die life for tool-steel dies may be in excess of 500,000 parts or more, with carboloy sets running well into the millions. Such factors as speed of production, the powder used, design of the die, and tolerances required all govern how long a given set may last.

DESIGN AND FABRICATION CONSIDERATIONS

As in any process, there are general rules which may be applied in designing for powder metallurgy. However, these suggested rules should not be allowed to take the place of consultation with the powder-metallurgical engineer or fabricator. His experience remains invaluable in arriving at the design which best meets the requirements of utility and appearance, and, at the same time, lends itself to economical production by the process. Hence he should be consulted as early as possible when designing parts for powder metallurgy.

Among the basic considerations in design are the properties of the material and the limitations of the fabricating and finishing processes to be used. Powder-parts fabricators are ingenious in designing dies and producing parts, but they are subject to limitations in what they can do. Modern pressed-powder parts have useful properties, and skillful design consists in making the most of these properties.

PHYSICAL AND MECHANICAL PROPERTIES

The majority of structural powder parts are porous to some extent. The exact amount of porosity depends on such factors as the compacting pressure, sintering time and temperature, and on subsequent coining or repressing operations. However, Table 1 shows results which were obtained on test bars, and it will be noted that the tensile strength, for example, is comparable to what might be expected on a cast bar of similar composition.

It should be remembered that the powder metallurgist has fewer restrictions placed upon him as regards composition. He can press a part from iron powder and by impregnating it with molten copper or brass, eliminate most if not all porosity. By so doing, it is possible to obtain tensile strength in excess of 75,000 psi.

Iron parts can be hardened by standard methods or by variations of them, and Rockwell C values as high as 60 to 65 have been consistently obtained.

It should be added that new alloys are constantly being produced and tested and many of these have improved properties.

TABLE 1 AVERAGE TEST-BAR TENSILE STRENGTH AND ELONGATION VALUES DETERMINED ON FOUR BRASS POWDERS

—Nominal composition—				Sintering range,	Tensile strength,	Elongation,
Cu	Zn	P	Other	deg C	psi	per cent
70	30	...	...	880–900	36000	14
70	30	0.3	...	820–860	36000	48
78.5	20	...	1.5 Pb	860–900	30000	12
64	18	...	18 Ni	940–980	44000	10

DESIGN LIMITATIONS

Actual design of a part is governed by the characteristics of metal powders and by die and press limitations. For example, undercuts are impractical. The situation is different from die-casting, where holes can be cored in almost any direction and threads usually can be cast. Because of the flow, or rather, the lack of flow, any coring in a powder part must be parallel to the direction of pressure application, and threads representing undercuts are, at least today, impossible to press in place.

One notable exception to this rule, and it is a special case, is in helical gears. Two fabricators have developed methods whereby they can produce gears successfully with a maximum helix angle of 26 deg.

Fig. 7 is an example of a part with undercuts, demonstrating several advantages as well as limitations. This is a drawing of a hypothetical part, cylindrical in shape with a flange at one end, an annular groove between it and a flange at its central portion, and a keyed square hole running its length. As shown here, it would be impossible to produce both flanges and the annular groove because the part would be impossible to remove from the die. Although split dies have been tried, at this stage of development they are not considered practical.

Besides the impossibility of removing the pressed part from the die, there is still another and perhaps more important difficulty involved with such a design. Dies are gravity-filled with powder and, in an automatic operation, it would be impossible to insure filling the lower flange; and, even if the lower flange were filled, pressure applied at the top only would not be sufficient to provide an adequately dense part.

However, notice the square center hole and keyway. Since these are parallel to the direction of pressing, they are entirely practical. In actual practice there is very little limitation as to the cross-sectional shape of these holes and D-shaped, square or rectangular holes, centrally located or off center, are easily produced.

One solution to the problem of pressing the part described would be to make it with the flanges combined into one, and subsequently machine out the slot and annular groove between them.

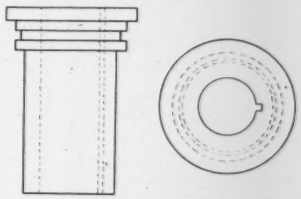

FIG. 7 BECAUSE OF UNDERCUTS, IT WOULD BE IMPOSSIBLE TO FORM THIS PART TO FINAL SHAPE

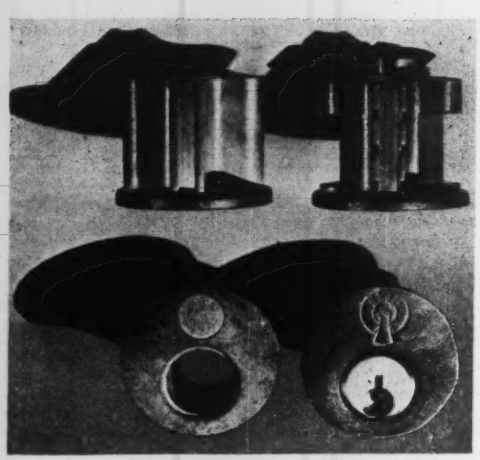

FIG. 8 PARTS SHOWN AT LEFT ARE AS PRESSED; THOSE AT RIGHT ARE FINISHED-MACHINED CYLINDERS

Another factor presented by poor flow is in the variation in density within a given part. The simplest example of this is in cylinders. If pressed from one end only, the density is found to be greatest at the outer edge of the end immediately adjacent to the punch. The density at the other end will be less, but greater at the center than at the edge. If pressed from both ends, lowest density will be found at the outer surface midway between the ends. This phenomenon puts a limitation on the length-to-diameter ratio, since, if the ratio is too high, the part will not have sufficient strength through the center portion. Also, the shrinkage which will take place during sintering—being governed in part by density—will be uneven. The general rule is that length to diameter should not exceed $2^1/_2$ to 1. There are exceptions, but those, in general, are cases where the strength of the center section is not too significant.

Powders obviously are compressed during pressing—how much depends on the specific powder used and on the compacting pressure. Since powders will not flow appreciably under pressure, wide variations in section thickness can cause trouble. Fig. 8 is of a lock cylinder, and it is a good example of this problem and how it can be overcome. If a 3-to-1 compression ratio for the brass powder used to make it is assumed, that is, if it is assumed that the loosely packed powder will compress to $^1/_3$ of its original volume during pressing, it readily will be seen that the die fill based on the body of the cylinder will result in a ratio of approximately 25 to 1 on the flange. If such a part were pressed in an ordinary three-piece die set, either the punch or die body would break during the first cycle.

To overcome this problem, it was necessary to devise a method whereby both body and flange received the proper amount of powder. There are several ways that this can be accomplished. For example, a multiple-action press can be used, or that portion of the die which forms the flange can be spring-mounted. When empty, this flange portion rises to a point where the fill will be in the 3-to-1 ratio. Under pressure, this section backs down ahead of the punch until properly positioned, at which point it is solidly seated and compression takes place. Unequal densities still are present, but not so severe as to damage the finished part.

This lock cylinder is interesting for several other reasons. Twelve machining operations remain after pressing, but the sand-casting previously used required twenty-six. It will be noticed from the illustration that there are two milled slots, one on each side of the body. These, being undercuts, cannot be pressed in place. Also, the finished lock cylinder has 5 or 6 holes drilled in it to house the tumbler pins. Because these holes are at right angles to the direction of pressure application, they cannot be formed in pressing but are drilled later.

A logical question at this point is that, since it is necessary to perform 12 machining operations, what are the machining characteristics of the pressed-powder parts? These cylinders are made from an 80–20 leaded brass powder and, according to one of the largest consumers, have better machining characteristics than a cast brass of similar composition. This is due, in part at least, to the complete lack of inclusions in the powder lock cylinders, such as sand or slag, and in the uniformity of all the cylinders.

One final example of how designing eliminated an undercut is shown in Fig. 9. This gear is the drive mechanism for an automatic record changer. The gear shown on the left is as it was originally designed and, as can be seen, required machining. The gear on the right is the final design. It will be noted that the single drive tooth is merely an extension of one of the lower full set of teeth. The section of the one tooth which was originally removed does not in any way interfere with operation, so it is left in place.

FEATHER EDGES—SIZE

In designing, it occasionally develops that the toolmaker, in order to form the proper contour of a rounded part, has to have a feather or very thin edge on the punch or ejector, as shown on the left in Fig. 10. This is not good practice, for no die material can be expected to withstand the necessary pressures in such thin sections. Such tool design can be avoided by including a small flat area as shown in the right-hand illustration. Usually this can be done by designing, and it frequently makes the difference between an impossible design and one that is perfectly feasible.

How small can a part be and remain practical? The ultimate in smallness depends on the ability of the powder rapidly to fill all parts of the die evenly in the allotted time. Fig. 11

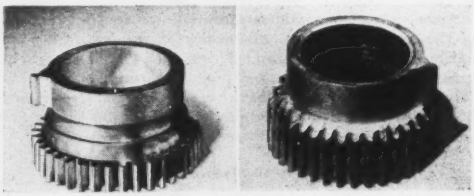

FIG. 9 ORIGINALLY MACHINED AS SHOWN AT LEFT, IT WAS FOUND THAT THE PART AS PRESSED—SHOWN AT RIGHT—WAS JUST AS SATISFACTORY AND MORE ECONOMICAL

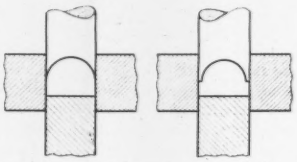

FIG. 10 IF POSSIBLE, FEATHER EDGES SHOULD BE ELIMINATED BY INCLUDING A FLAT AREA AS SHOWN AT RIGHT

shows parts which are fairly small. The small gear is abouts 0.2 in. diam; the Y-shaped piece measures approximately 0.125-in. across the top, 0.1 in. at the bottom, is 0.2 in. from top to bottom, and 0.125 in. thick. The bushing shown is 0.1 in. thick and slightly less than 0.25 in. diam. Smaller parts are possible, but the lower limit appears to be between 0.02 in. and 0.03 in. in the dimension perpendicular to the direction of pressure application.

How large a part may be depends in part on the size of the available press equipment. It requires from 30 to 50 tons pressure per square inch to form most structural parts. As presses become larger, they become slower, and some of the advantage of speed is lost. Probably more important, as size increases, problems which can be ignored in small parts become increasingly critical. Differences in density which will cause variations in shrinkage may cause warpage or cracking and, as a result, more complex dies are required to reduce density variations to a minimum.

As an example of an extreme case of die complexity, consider the gear shown in Fig. 12. This gear is approximately 3 in. diam, and the hub is approximately $1^3/_{16}$ in. thick. To form this part with all its different sections, a twenty-three piece die was required. It might be added that, although this gear is a successful application, it is being redesigned to simplify the die equipment. Larger parts are being made and will be made, but before spending a great deal of time designing a large part, it is best to consult a fabricator first.

DESIGNING FOR POWDER METALLURGY

The illustrations which have been shown represent, for the most part, adaptations to powder metallurgy of parts made by other processes. It stands to reason that if a process has value, its maximum benefits will be achieved by taking into consideration its advantages and designing parts specifically for it. Fig. 13 is an example of this. Here are shown a padlock body, outer cylinder, inner cylinder, and bolt which were designed for the process. As a result, two of the parts—the body and the inner cylinder—would be impractical to make by any other process. In addition to this important factor, if the components were designed for another process, let us say extrusions, the cost of tooling to assemble and machine these pieces would have been considerably greater.

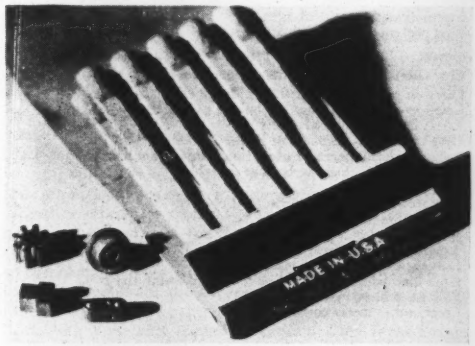

FIG. 11 SOME IDEA OF SIZE OF PARTS CAN BE GAINED BY COMPARING THEM TO BOOK OF MATCHES

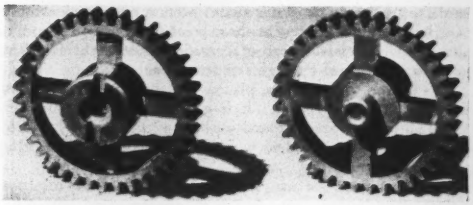

FIG. 12 ALTHOUGH REQUIRING COMPLEX TOOLING, THIS LARGE GEAR, WHEN MADE OF IRON POWDER, REPRESENTED A MUCH LOWER COST THAN ITS MACHINED COUNTERPART

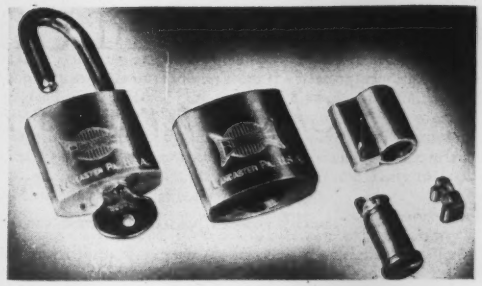

FIG. 13 EXCEPT FOR PINS, SPRINGS, AND SHACKLE, MAJOR COMPONENTS OF THIS PADLOCK ARE MADE OF BRASS POWDER

Powder metallurgy has a great advantage in that, by a fairly simple and very rapid process, it can form parts to close tolerances. One lock manufacturer estimated that to tool for machining and assembling extrusions or castings would cost approximately $40,000, while tooling to handle the pressed-powder parts involved an expenditure of less than $10,000.

Although powder parts can be given a scratch brush or polished and lacquered finish, it is only recently that a plated finish has been practical. Research by several companies has developed methods of applying most commercial plated coatings. For example, today a lock manufacturer is successfully applying a copper-nickel-chromium plate, and cadmium, silver, and bronze plates are all in use.

CONCLUSION

The applications which have been discussed represent only a few of the many which are now being produced and used successfully. It should be remembered that, although the basic process is ancient, modern powder metallurgy, as we know it, is still an infant industry. New applications are constantly appearing as more and more companies become aware of the savings and other advantages of designing for powder metallurgy.

ACKNOWLEDGMENT

Acknowledgment is hereby made to the following concerns for their help in the preparation of this paper: F. J. Stokes Machine Company, The Drever Company, The Presmet Corporation, Watertown Manufacturing Corporation, and the American Sintered Alloys Corporation.

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GRINDING FLUIDS

Characteristics and Applications

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INTRODUCTION

THERE are just two all-important positive functions of grinding fluids—lubrication and cooling. The term "coolant" is commonly applied to the fluids. Cooling was the initial primary function, and its need is still the more apparent. However, as more and more lubrication has been built in, lubrication has become equal in importance to cooling on a number of grinding operations.

The purposes of this paper are as follows:

1 To classify the fluids with reference to make-up.
2 List positive and negative functions of the fluids.
3 Rate types of fluids with regard to ability to fulfill the functions.
4 Discuss some aspects of application.
5 Present a theory of the benefit of lubrication to grinding.
6 Correlate lubrication from the fluid with surface finish on the work ground.
7 Utilize data from experimental grinding to illustrate the statements made concerning lubrication.

Treatment of the phases will be mostly of effects in grinding with little space given to chemical composition of the fluids.

NOTES ON CHARACTERISTICS

Classification. There may be as many varieties of classification of grinding fluids as there are classifiers. Table 1 is made up largely with reference to composition, omitting commercial or trade names.

There is a tendency among some users to apply the term "soluble oil" to all liquid grinding compounds to be mixed with water, whether the compound makes a solution or an emulsion in water, and whether or not it contains oil. To cope with this situation, the word "synthetic" has been applied to some products. Those who recommend and distribute grinding compounds should be encouraged in their efforts to maintain logic in the designations.

It is pointed out that fatty oils also are ingredients of some of the "solubles."

Of the classes of fluids listed, certain ones are used to a minor extent. They include solutions of plain soap and straight mineral oils Pastes used to a large extent in years past have been largely superseded by liquid compounds miscible in water. The so-called "synthetics" are gaining in favor.

The fact that some grinding chemicals, which make true solutions in water, come in solid or powder form is recognized but is not discussed.

Functions. The functions are grouped under two headings, positive and "negative," in Table 2. Positive ones are those which provide advantages over dry grinding.

Contributed by the Research Committee on Cutting Fluids, Lubrication Committee, and the Production Engineering Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 1 CLASSIFICATION OF GRINDING FLUIDS

1 Air
2 Plain water
3 Water with rust inhibitor
4 Water emulsions of the following:
  (*a*) Mineral oils
  (*b*) Mineral oils with extreme-pressure additives such as sulphur and chlorine
  (*c*) Synthetic soluble oils
  (*d*) Pastes made up with soap
5 True solutions in water of the following:
  (*a*) Alkalies
  (*b*) Synthetics (chemical compounds)
  (*c*) Soaps
6 Kerosene
7 Straight mineral oils
8 Grinding oils—mineral oils plus additives, such as fats, sulphur, and chlorine

TABLE 2 FUNCTIONS OF GRINDING FLUIDS

Positive:

Lubrication—to reduce loading, glazing, friction
Cooling—for comfortable handling, dimensional accuracy, and wheel protection
Rust prevention—of work and machine

Negative:

Characteristics which minimize tendencies to:
Carry chips back to point of grinding
Cause trouble when "hard" water is part of fluid
Affect hydraulic oils adversely
Give off unpleasant odors or fumes
Irritate or stain operator's breathing apparatus or skin
Decompose or otherwise become unstable
Cost too much
Obscure vision of work because of opacity
Create a fire hazard
Weaken bond of a grinding wheel
Attack paint on machine
Leave sticky deposit on machine parts
Gum-load wheel face (may be related to instability)
Produce prolific foaming
Create other messy conditions

The ramifications of lubrication will be discussed under a later heading.

Cooling is important as applied to both the work and wheel, especially in heavy grinding. It contributes to comfortable handling of the work, dimensional accuracy, and reduction of gross heat strain. It prevents heat breakage of vitrified bonded wheels and excessive wear of organic bonded wheels whose bonds are weakened by high temperatures.

Rust prevention might be placed in either category, depending upon one's viewpoint. It is given a positive rating here because a piece of steel ground with an adequate rust inhibitor in the fluid is considered to be more effectively protected than one that is ground dry.

Negative functions are those which reduce or minimize undesired conditions not present in dry grinding but which may appear only because a liquid is used. They are many in number but must be met in order to realize benefits of the positive functions.

Most of the negative functions are obvious and need no discussion. Mention will be made here of two.

There is sometimes a chance that the grinding fluid may leak into the hydraulic system of the machine. If that occurs the fluid should not impair the functioning of the oil. An alkaline solution has been known to break down some of the hydraulic oil, form a soap, produce a sticky deposit in control ports, and shut down the grinding machine.

Some wheel bonds can be weakened by some chemicals. Vitrified and metal bonds are generally immune to all known compounds, but resinoid, shellac, and silicate bonds can be affected by alkalies, and a rubber bond can be affected by oils. Whether or not the effect becomes serious depends upon a number of circumstances such as concentration and time factors.

Ratings of Fluids. In the simple tabulation of ratings in Table 3, only three kinds of functions are recognized. The most definite rating can be made with reference to cooling. Relative lubrication value will depend partly upon the type of work to be ground. It should be kept in mind that the many varieties of water emulsions and solutions possess a wide range of lubrication and negative function characteristics.

TABLE 3 RATINGS OF FLUIDS

	Fluid	Lubrication	Cooling	Average of desirable negative functions
1	Air	"None"	Lowest	Highest
2	Plain water	Low	Very high	High
3	Water with rust inhibitor	Low +	Very high	High
4,5	Water emulsion or solution	Moderate ±	High ±	Low to high
6	Kerosene	High	Low	Low
7	Straight mineral oil	High	Low	Low
8	Grinding oil—mineral oil plus additives	Highest	Low	Low

NOTES ON APPLICATION

Wet-grinding is employed for most medium and heavy precision-grinding operations and for abrasive cutting off with rubber-bonded wheels. Most snagging, much tool grinding, and some surface grinding and cutting off are done dry. The operation is dry when neither cooling nor liquid lubrication is required or when the problem of controlling and confining a liquid is considered to be too difficult.

Application of a liquid is a matter of selecting one which has the characteristics to meet the requirements of the job. Many questions of application are answered by the descriptions found elsewhere in the paper.

If cooling is the only requirement, plain water is the answer and at minimum cost. If corrosion of ferrous work and of the machine are to be prevented, a rust inhibitor is added to the water at a low cost.

If more benefit to grinding is desired by way of lubrication, one of many grinding compounds available (containing a rust inhibitor) is added to the water. If a "sticky" metal such as soft stainless steel or aluminum is being ground, there are special solubles which reduce loading materially, without the use of a grinding oil. "Grinding oil" means oil with no water.

When maintenance of shape of wheel face is of paramount importance, a grinding oil is the right medicine. Examples are in thread-grinding and crush-dress form grinding. To hold form of wheel face, heavy pressure must not be built up under a set feed. To limit the pressure the wheel must be kept sharp. Lubrication from the grinding oil maintains sharpness by retarding both loading and glazing as explained later under "Lubrication."

Going from a water compound to grinding oil has also been known to eliminate serious heat injury to ground work. The reason is that more complete lubrication reduces the amount of heat generated at grinding contact. Injury to sensitive steel, such as softening or cracking from the heat of grinding, occurs at grinding and is not eliminated by removal of residual heat by the fluid directly after grinding contact. Delayed cracks due to stresses set up by abusive grinding sometimes form long after heat has been extracted from the work by the coolant. Except for very sensitive steels, cracking is not likely to occur when no burn color appears in grinding.

Grinding oils benefit most operations. They increase wheel life, cause a freer cut, permit a higher rate of production, or combine two or more such advantages. The higher rate of production is attained because the rate of infeed can be increased and because the time of "die out" at the end of the cut is less, permitting an automatic cycle of shorter period. The reason oils are not employed more universally is that they are more expensive and create certain nuisances. They have only about 10 or 20 per cent of the ability of water to extract heat from the work and they can make a mess of the surroundings with fumes and spatters. The problem is more pronounced when the grinding is heavier. A part-way solution of the cooling problem is to refrigerate the oil. Air exhausts and precipitators are often installed to take care of the vapors.

Concentration of a soluble in water ranges roughly from 1 part in 10 to 1 part in 100 parts of water. Different proportions are sometimes recommended for the same brand, depending upon circumstances. The average proportion is estimated to be near 1:50. Ratios named in the paper are all by volume.

The limit of leanness should be, perhaps, the loss of protection against rust. A richer and richer mixture provides more lubrication but costs more and is more likely to lead to foaming and, in some cases, to "gum loading" of the wheel face. A very rich mixture also has somewhat less cooling ability than a lean mixture.

Gum loading apparently starts with jellylike particles of the compound collecting in the pores of the wheel. Fine grinding swarf then becomes attached to the initial deposit and reduces grinding clearance between abrasive grains.

There are some work materials the grinding of which apparently is benefited but little by lubrication. In one instance, cemented carbide was ground practically as well with a water emulsion as with oil. It may be that cooling and washing of the wheel face were the only functions of value performed by the fluid.

Much commercial grinding of high-speed tools is done dry. Laboratory runs in some cases have indicated no benefit from water emulsion over dry-grinding of such steels.

A well-seasoned bit of advice is that when grinding is wet it should be all wet. The liquid should flood the grinding zone. An intermittent or scant flow may be more harmful than no flow at all.

Application of liquid through the body of the wheel—thrown out by centrifugal force—is growing. The advantage of getting more fluid in between the wheel and work seems to be well established. How far the practice will go depends, in the author's opinion, upon the handling of three problems: (*a*) selection of an effective liquid which does not clog the wheel pores, (*b*) completely effective filtering, and (*c*) control of the superfluous flow from about 340 deg of the wheel's periphery.

LUBRICATION IN GRINDING

Cooling of the work and wheel by the fluid is a simple function. Lubrication of the grinding operation—that is, at contact—is a function about which we can indulge in considerable speculation.

The obvious primary benefits of lubrication are prevention of severe loading of the wheel face, and retardation of dulling of the abrasive cutting points.

Simple loading is the adhesion of chips, of the work ground, to the working face of the wheel. In severe loading, the initial chip caught on the wheel face takes on more and more chips, filling clearance pores and covering abrasive points. The impediment to grinding is obvious, because steel does not grind steel effectively. Adequate lubrication makes it difficult for a chip to get an initial foothold and to hang on. Furthermore, it is believed that an extreme-pressure lubricant when present prevents additional chips from building up on those that do gain an initial foothold by means of chemical reaction.

Dulling of the abrasive points leads to what is called a "glazed" wheel face. There is little or no fracture of the abrasive grains but flats are worn on them, and penetration of the work becomes difficult. The flats may or may not be covered with a thin film of metal, when metal is ground. The wheel face appears shiny by reflected light as though made up of tiny sections of a mirror. Continued feed of the work leads to heavy pressure, generation of much heat and often injury to the work.

The kind of wear of the abrasive cutting points which leads to glazing is called "attritious wear." Attritious wear of the abrasive point depends not only upon relative hardness of abrasive and work but also upon chemical correlation between the two. Wear is believed to be affected by solubility of the specific abrasive in the specific work material. Aluminum oxide and silicon carbide are both much harder than glass; yet the aluminous abrasive has much more rapid point wear on glass. On hard steel, the order of wear is reversed and silicon carbide dulls more rapidly than aluminum oxide even though it is harder than the latter.

The medium present at the abrasive-work contact has been found to have a marked effect upon rate of attritious wear of the abrasive. The medium which retards attritious wear the most is said to have maximum lubrication in that respect. Among three mediums tried, grinding oil was found to be the most beneficial lubricant, because abrasive wear was the least in it. Atmospheric air was intermediate, while wear was most rapid in water.

Lubrication in grinding, then, may be summed up as the act of keeping the wheel face sharp by combating both loading and attritious wear of the abrasive points.

FINISH ON GROUND WORK

A few words may well be spent on effects of the fluid upon the finish left on the ground work surface. For reference, take the finish left by a wheel just after it has had a fine diamond truing, free from diamond marks and chatters, and with a profilometer reading of, say, 20. After that, the finish can become less perfect from glazing, loading, or rapid wear of the wheel face.

Glazing builds up heavy pressure which in turn tends to produce vibration and chatters, even though a high luster is maintained. Appreciable wear of the wheel face permits new sharper grains to come into play and deeper grain marks are left which yield a higher Profilometer reading. Wear is also likely to be nonuniform around the wheel, which condition also produces chatters. Particles of load attached to the grinding face will impair the finish by scratching it.

The general correlation is now stated in a few words. The fluid which provides more effective lubrication retards the undesired changes and maintains the desired finish for a longer time.

Incidentally, a very fine finish can be marred by scratches from grinding swarf carried to the grinding zone by the liquid. One which permits rapid settling of the chips in the tank is preferable in such case, but the most positive remedy is to filter the fluid just before it reaches the wheel and work.

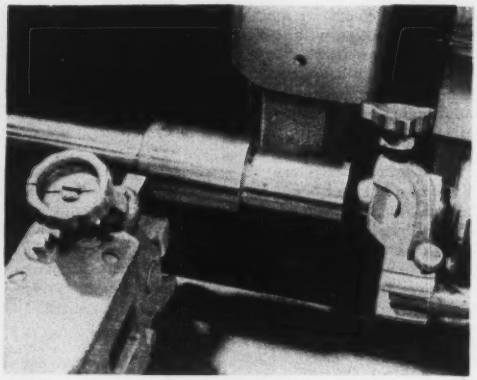

FIG. 1 SETUP FOR CORNER-WEAR TEST FOR GRINDING FLUIDS
(A crankpin grinding wheel and a forged crankshaft steel workpiece are shown.)

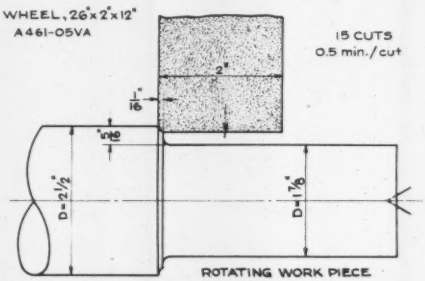

FIG. 2 SKETCH OF ARRANGEMENT IN FIG. 1
(Wheel is shown early in cut which is made to a depth of 5/8 in. on diameter of work, and which takes 1/2 min.)

EXPERIMENTAL DATA

The experimental evidence to be offered is in support of statements made concerning lubrication from grinding fluids.

The first data to be shown are from what is called a corner wear test for crankshaft wheels. The setup is illustrated in Figs. 1 and 2. For comparing grinding fluids, all conditions are kept constant except the fluid and diameter of wheel. When the wheel is worn to less than 26 in. diam, the result is adjusted by calculation to essentially the value that would be obtained at the 26 in. diam.

The wheel corner is first trued so that the radius is practically 0. Then 15 cuts are made, and the radius of the fillet is measured. A lower fillet (corner wear) reading means a more favorable performance.

The operation really is a severe test of a small width of the wheel face when grinding medium-soft forged crankshaft steel, as based upon commercial practice. In production grinding of crankpins, frequency of retruing and wheel life depend upon corner wear. The test is employed for the following reasons:

1 It is rapid.

2 Results are quite reproducible compared with other grinding operations.

3 It represents a production operation.

Table 4 gives typical results from different types of fluids.

The corner wear is less from dry-grinding than with most of the water fluids. The reason is thought to be due to softening of the steel from the high temperature generated under the rapid rate of feed. A severe burn is left on the side wall of the work; consequently dry-grinding is not recommended for the full cut in practical operation.

TABLE 4 TYPICAL COMPARABLE DATA FROM CORNER-WEAR RUNS

Fluid	Radius of fillet after 15 cuts in units of 1/64 in.
Air (dry grinding)	8.5
Water only	11.5
Water with rust inhibitors (3 kinds)	9–12.5
Water with compounds (25 or more brands)	8.5–11.5
Straight mineral oils (jet) (3 varieties)	7
Grinding oils (jet) (20 or more brands)	5–7
Water with a compound, normal application	10
Water with a compound, jet application	9
A grinding oil, normal application	6
A grinding oil, jet application	5

All liquids keep the work cooler so that there is probably little or no aid to grinding from softening of the work. Lubrication then becomes the important factor, by reducing load on the wheel corner. Glazing of the chamfer on the wheel corner probably is not an important factor because of the rapid wear of wheel structure. The abrasive points do not have time to glaze much before they are fractured or torn out.

When plain water is used, corner wear is higher than with water plus most of the compounds, and the side wall of the work is burned but not so severely as in dry grinding. Some rust inhibitors provide lubrication and definitely reduce the wear. Most grinding compounds in water provide more lubrication. The range shown is significant, but it is often difficult to correlate the figures with the composition or even type of compound. The latter information was not generally available when the individual compounds were tested. The impression, however, is that "synthetics" stand high in this test. Burning of the side wall occurred with some products, but was not related definitely to magnitude of corner wear. Statistically, it was more prevalent with pastes than with liquid solubles.

Going to mineral oils and then to grinding oils shows two additional desired reductions of corner wear. The actual economical gain is even more than that indicated by the tabulated figures. For example, when the oil which resulted in the minimum fillet of 5 units at 15 cuts was used, it was found that 60 cuts could be taken before the fillet reached a reading of 10, which was reached in 15 cuts with a typical water compound. Thus we have an indication of a fourfold increase in wheel life when going from a water mixture to a grinding oil.

Separate experiments have indicated that grinding is improved when either a fat or an extreme-pressure lubricant is added to a mineral oil, which then becomes a grinding oil.

Results from oils are first listed in the table from jet application because most of the oils were run that way. The lower lines show a minor gain for jet over normal low-velocity flow application. The jet was produced by a pressure of about 50 psi behind an orifice of about 0.075 in. diam. It was shot into the wheel at a point just above grinding contact with the object of getting a maximum amount of fluid into that contact.

Table 5 shows what was accomplished by a special-purpose compound when grinding two "sticky" metals cylindrically.

TABLE 5 TRAVERSE GRINDING RESULTS ON STICKY METALS

Compound	Mixture	Relative apparent wheel wear, mils	Maximum power, kw	Profilometer reading
ALUMINUM				
General purpose	1:40	14.5	4.5	525
Special purpose	1:15	0.5	3.0	30
STAINLESS STEEL				
General purpose	1:40	20	3.0	150
General purpose	1:15	16	2.25	80
Special purpose	1:15	11	3.0	55

Here again, reduction of loading is believed to be the principal benefit. As a matter of fact, loading of aluminum was so pronounced with the general-purpose compound that the work was actually chopped off by aluminum stuck to the wheel face, as evidenced by the very high profilometer finish reading of 525. Along with this excessive loading, 50 per cent more power was required to drive the wheel. This heavier burden caused many times as much wheel wear as when the special-purpose product, of more beneficial lubrication, was used.

The significance of power in these data is not in its cost but as an index of freeness of cut. More power means more pressure, more heat generated, and more difficulty in attaining dimensional accuracy. Uniform as well as low power is also desired. Uniform power means steady consistent grinding action, conducive to fast production.

A richer mixture of the special-purpose than of general-purpose compounds is generally recommended. To eliminate this variable, the experiment was tried of running both at the same mixture of 1:15 on stainless steel, when a large difference of wheel wear in the same direction is still evident.

The special-purpose compound of Table 5 is classed as a "synthetic soluble" with considerable saponifiable-oil content.

The wheel wear is called "apparent" because it was calculated by subtracting material removed from total feed. For practical purposes, apparent and actual wheel wears are equal since springback in the setup is negligible.

Table 6 is a comparison of a successful general-purpose commercial compound in water with a grinding oil for plunge-cut crush-dress form grinding. When a 60-grit wheel was used on soft steel, wheel wears were practically alike, but power was considerably lower and finish was kept finer with oil.

TABLE 6 CRUSH DRESS GRINDING

Fluid		Pieces ground	Apparent wheel wear, mils	Net peak power kw	Profilometer, last piece
A60-L5V WHEEL ON SOFT STEEL					
Compound-water	1:50	10	6	5.2	65
Grinding oil		10	6.5	3.5	45
A220-L8V WHEEL ON HARDENED STEEL					
Compound-water	1:50	3	84	5.5	45
Grinding oil		10	6.5	3.1	32

When a 220-grit wheel was used on hard steel, the operation was successful with oil but not with water plus compound. After only three pieces had been ground, wheel wear was so great as to ruin the form of the wheel face.

Suppose we now give some attention to grinding a material other than metal. During World War II many diamond cut-off wheels and many grinding fluids were tested for slicing natural quartz crystals into wafers for radio control.

Fig. 3 shows the effect upon rate of cut, under constant pressure, when using three different fluids. The most outstanding contrast occurs at a total cut of 8 sq in. where about 0.4

min is taken to cut 1 sq in. of quartz with a light oil, while 1.9 min, or nearly 5 times as much, is required with an ordinary compound, 1:20 in water. Enriching the mixture with the same compound to 1:5 reduces the time per cut but does not bring it down to that of a light oil.

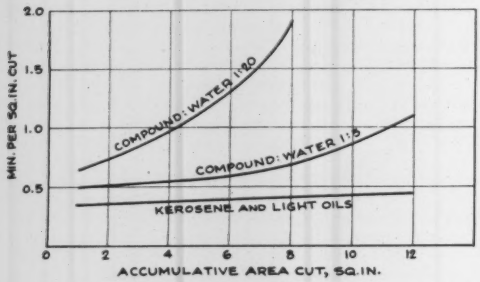

FIG. 3 CURVES SHOWING EFFECTS OF THREE GRINDING FLUIDS UPON DULLING OF WHEEL AND LOSS OF FREENESS OF CUT, UNDER CONSTANT PRESSURE

(Section of quartz cut was $\frac{3}{8}$ in. × 2 in., rectangular.)

Difference in freeness of cut as between oil and water plus compound in glass-lens surfacing is similar to that cited for quartz cutting. In both applications the oil is believed to aid mostly by retardation of attritious wear of the diamond points.

Table 7 provides some figures illustrating the effects of fluids upon attritious wear of abrasive points. The data are not from grinding as such but from measurements of point wear of abrasive specimens after they had made a trace of about 75 ft on a cylindrical workpiece under light pressure (8 oz) in a lathe (Fig. 4).

The data should be taken as exploratory and approximate but it is believed that they point out at least the order of glazing of the respective abrasives on the respective work materials in grinding.

Note that attritious wear (dulling of the point) was greater when water was applied to the contact than when the medium was air or oil. From the figures and from practical experience, we conclude that water encourages dulling, while oil is the most effective retarder known.

Not a great deal is known about the physical and chemical reactions involved when the fluid affects attritious wear. An intensive experimental study is now in progress, and it is hoped that much more light will be shed on the subject at a later date.

There certainly must be some reaction involved when it is observed that wear of aluminum oxide is hundreds of times faster on glass than on the harder hardened steel, and when it is observed that oil permits only a third or fourth as much wear as water when an abrasive is run on steel.

SUMMARY

The two important positive functions of grinding fluids are lubrication and cooling. Lubrication maintains sharpness of the grinding tool and contributes to uniformity of finish on the work, by reduction of loading and glazing of the tool. Cooling contributes to comfort in handling and to accuracy of work and protects the wheel and work from heat injury.

Among fluids in common use, grinding oils provide maximum lubrication, and water (alone or with compound) provides maximum cooling. Oils are more costly and present more problems in combating the inconvenience of using a liquid, than do water-compound mixtures, but are essential and more economical in many grinding operations.

Grinding compounds, miscible with water, bracket a wide range of characteristics. Selection of type to fit the requirement is important.

TABLE 7 ATTRITIOUS WEAR OF ABRASIVE POINTS ON HARDENED STEEL, Rc 60

Abrasive	Typical wear in cubic microns per foot of trace: Air	Water	Oil
Aluminum oxide	20	45	10
Silicon carbide	65	95	30

TABLE 8 ATTRITIOUS WEAR OF ABRASIVE POINTS ON SODA-LIME GLASS

Abrasive	Air	Water
Aluminum oxide	2000	12800
Silicon carbide	120	1300

ACKNOWLEDGMENTS

Mr. G. J. Wickstrom, Norton Research Laboratories, conducted most of the experimental grinding, from which data are quoted, and supplied counsel from his long experience with precision grinding. Mr. L. Coes, Jr., Norton Research Laboratories, assisted the author in classifying grinding compounds and with physical and chemical information concerning them. Thanks are due also to several representatives of oil companies for aid in classification and for other information concerning their products

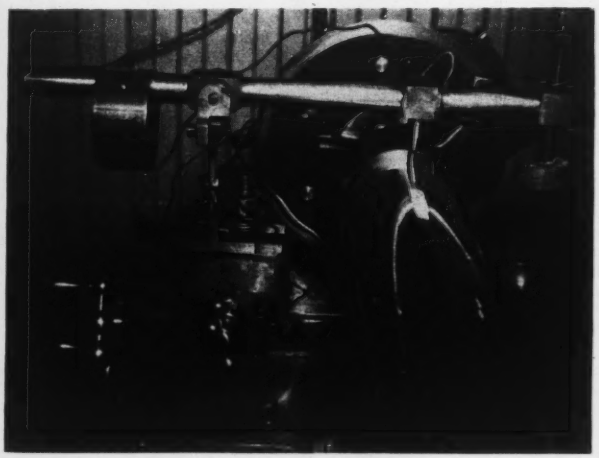

FIG. 4 ASSEMBLY ON LATHE FOR MEASURING ATTRITION RESISTANCE OF ABRASIVE POINTS

(Abrasive specimen was ground to conical point of 135 deg included angle and was inserted in part projecting from under lever, directly over roll of work material. Tool carriage supported and traversed the lever and abrasive specimen as the roll was rotated.)

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Electric Power

FACTS, figures, and estimates concerning electric-power production in the United States were discussed by Charles E. Wilson, Mem. ASME, president, General Electric Company, now Director of Defense Mobilization, before a meeting of the National Press Club in Washington, D. C., recently. He said that certain of our government bureaus have been among those claiming that as we crank up our defense program and bring it to speed, we are going to have a serious power shortage unless something drastic is done to prevent it. Spokesmen for the private utilities say this isn't so.

There is today enough power to meet present needs with a safe reserve margin, Mr. Wilson indicated, and there will continue to be enough power to meet anticipated needs if the equipment —now on order and planned—is built and installed as scheduled, despite a shift to a partial war economy. There will be, in our judgment, he said, no power shortage unless one or more of the following things happen:

1 If major war-production projects, such as aluminum plants or special new bomb projects, are heedlessly located in sections of the country where power can't be made available to them.

2 If the present manufacturing facilities for utility power-supply equipment are diverted to other purposes, thus delaying production schedules of equipment already on order.

3 If the materials necessary to produce this equipment are not made available as a vital part of the over-all defense program.

In the General Electric Company, Mr. Wilson stated, we estimate that all defense expenditures will increase from the 12 billion dollars of 1949 to about 46 billions in 1952, dropping back to about 41 billions in 1953. We are assuming full-employment-capacity operation of all industry and continuing industrial expansion through 1953. We have factored in all the plans and commitments for war production that are known, plus a heavy production of civilian goods. We are assuming some lengthening of the work week. In estimating power requirements we are here considering what practically amounts to a wartime level of industrial activity.

On the basis outlined here we find there is indicated for 1953 a power load or total demand of 416 billion kwhr. This is 43 per cent higher than in 1949. We estimate the peak load, or the largest demand that will ever be made for electricity at a given time, to be 77.4 million kw in 1953, or 37 per cent higher than in 1949.

With the power-generating equipment that has already been scheduled by the electrical manufacturing industry through the first half of 1953, and assuming that the suppliers of power are permitted to install the additional capacity they have planned for the latter half of that year, the nation will have a margin of reserve generating capacity 20 per cent above the estimated load peak in 1953. In order to wipe out this margin of reserve, Mr. Wilson pointed out, we would have to see a growth of the electrical load through 1953 almost double (actually 95 per cent more) the increase of 87 billion kwhr we have estimated for this 1950–1953 period.

Incidentally, estimates of power requirements are based on median hydro conditions—drought would cut the margin of reserve capacity but would not wipe it out.

Suppose war production should be expanded beyond the levels forecast here—would there be sufficient electric power to support the added manpower available, he asked? Let us assume that we retain a reserve of 5 per cent of electric-utility generating capacity, to take care of breakdowns, and devote all the rest of the estimated 1952 margin to increasing production. In that case industrial production would be at a level which would require 5,700,000 (or 38 per cent) more manufacturing employees than today's high level, working 42 hr a week. And if they work 45 hr a week, the peak in the last war, we would still need 4,300,000 (or 30 per cent) more people. The labor force is growing approximately a half-million a year. We are already in a situation of almost full employment, and according to figures in the *U. S. News*, adding less than another 3 million will achieve peak defense production planned for the end of 1951. Simultaneously, we are driving for a 3-million-men fighting force. It would appear, therefore, that manpower—not electric power—would be the bottleneck in such an emergency, he stated.

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

It is worth noting that although the electric industry must have enough generating equipment available to meet the peak demand, even if it lasts but minutes or hours, this capacity is not needed for a large part of a normal one-shift day. Much of it can be put to work for many more hours. For three shifts the capacity is theoretically tripled, although from a practical production standpoint, a third shift never actually delivers its theoretical quota. Also, total power demand does not increase in proportion to the amount of power going into defense production. A substantial part of the added defense demand comes about automatically as a result of the diversion of manpower and materials; either of these is more likely to cause bottlenecks.

Figures from the manufacturing point of view, revealed by Mr. Wilson, indicated that the electric-power industry will ship in the three years 1950 through 1952, based on orders already scheduled, 21,300,000 kw of electric generating equipment. In 1953 they will need another 7 million kw and the industry will supply that.

To cover utility and other needs, including industrial and export, he said that we will have manufacturing capacity of 11 million kw in 1952, and General Electric alone will be able to supply 5,200,000 kw. Our capacity for large steam turbines alone has gone up 60 per cent in the last 10 years, Mr. Wilson said, thanks to a new 30-million-dollar turbine plant, covering 20 acres of land at Schenectady, completed in 1949. Today, he said, General Electric can produce more electric-generating equipment than the entire industry produced before the war, and twice as much as we produced before the war.

Electric Generating Station

ON Dec. 7, 1950, the Commonwealth Edison Company of Chicago, Ill., dedicated its first completely new generating station in more than 20 years. Ridgeland Station, located on the Chicago Sanitary and Ship Canal, is planned for an ultimate capacity of 600,000 kw. Preliminary work was started in August, 1947, and the first 150,000-kw unit was placed in service October 29, 1950; the second 150,000-kw unit is under construction and will be in service in 1951. A third unit, already authorized, will require extension of the building, and service is scheduled for 1953. The addition of the first Ridgeland unit brought the total net plant capability of the system to 2,802,000 kw.

The Ship Canal serves as a source of condensing water and also permits barging of coal. Fuel for Chicago stations is supplied from the Central Illinois coal fields and arrives at Ridgeland by rail or barge.

The Babcock & Wilcox cyclone-fired steam generators, two per unit, are rated at 730,000 lb per hr each at 1900 psi and 1050 F. Four-hour maximum rating is 770,000 lb per hr. The horizontal cyclone furnaces, four per boiler, are supplied with crushed coal from 1400-ton boiler bunkers through individual scales and apron feeders. Natural gas and coal can be burned in the cyclones in combination or alone.

To reduce atmospheric pollution electrostatic precipitators have supplemented the cyclone-firing method to reduce stack solids discharge to a minimum.

The first unit is a 150,000-kw Westinghouse, cross-compound turbine with a 50,000-kw 3600-rpm high-pressure element, and a 100,000-kw 1800-rpm tandem intermediate-pressure (IP)-low-pressure (LP) element. Both generators are designed for operation at 85 per cent power factor, hydrogen-cooled at 0.5 psig. With 15 psig hydrogen, the rated capability of the unit will be 15 per cent higher or approximately 203,000 kva. Rated voltage is 13.8 kv. Steam at 1800 psig and 1050 F is admitted to the HP cylinder through the two double-plug-type throttle valves, two steam chests, eight plug-type governing valves, and six segmental nozzle blocks. There is no stage bypassing under overload. The HP cylinder has one impulse stage (two rows) and 13 reaction stages with one extraction point. The IP cylinder has 27 reaction stages and two extraction points. The low-pressure (LP) cylinder has 10 double-flow reaction stages and two extraction points.

The main steam header and other high-temperature piping is hollow-bored chrome-molybdenum ($2^1/_4$ per cent chrome, 1 per cent molybdenum) steel pipe. The turbine throttle valves, governing valves, steam chests, nozzle chamber, and nozzle blocks are stainless steel.

Water for make-up and general station use is obtained from Lake Michigan, about 10 miles away. As the supply might be completely interrupted for intervals, two 200,000-gal underground reservoirs are provided.

The coal-handling plant consists of facilities for receiving coal by barge or rail, handling to and from storage, breaking and crushing for the bin system of cyclone firing, and delivery of the crushed coal to the boiler bunkers. The system initially consists of a series of single belts with handling capacity of 800 tons per hour. The ultimate handling system will consist of parallel belts with valves and cross-tie arrangements to provide a high degree of flexibility and outage facility.

The conveyers, breakers, crushers, and various feeders and valves in the handling system are remotely controlled from a central control room. A miniature system on the control panel indicates routing of the coal and equipment in service. Interlocks provide sequential starting and emergency sequential stopping of the various equipments. Such equipment as barge mover, crane, stacker and loader, car dumper and car puller are adjacently controlled. An intercommunication system co-ordinates the operations.

Slag is intermittently sluiced by hydrojet system from the quenching tanks (two per boiler) to an outdoor storage pit. The system is manually controlled.

Fly ash is intermittently removed from the precipitator hoppers (16 hoppers per boiler) and transported pneumatically under vacuum. After mixing with water in the multiwater-jet air ejectors (Hydrovactor) the ash is discharged to the outdoor storage pit. The system has automatic sequential control.

Control of boilers, turbines, generators, major auxiliaries, auxiliary power, and transmission for all units is centered in a single control room. The room is 40 ft × 96 ft at present but will be extended to 160 ft long and will be approximately centrally located in the ultimate building structure.

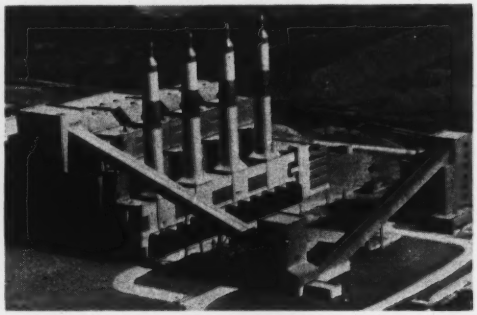

FIG. 1 OVER-ALL VIEW OF RIDGELAND STATION

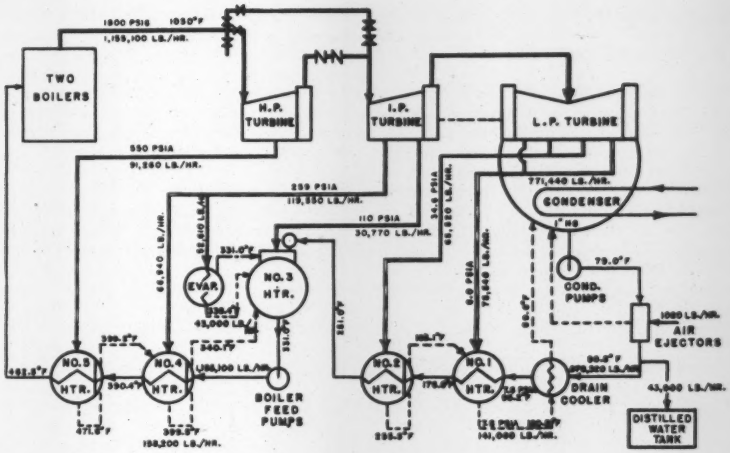

FIG. 2 FLOW DIAGRAM OF UNIT 2—RIDGELAND STATION

In general, the following operations can be performed by remote control: Cyclones can be fired and boilers can be put in service except for drain-valve operations. The turbine is brought to speed by an attendant at the unit and is controlled thereafter remotely. Major auxiliaries such as circulating-water pumps, condensate pumps, boiler feed pumps, turbine oil pumps, and exciters are remotely controlled. Emergency operations such as sectionalizing steam and feedwater headers, by-passing coal scales and feedwater regulators, isolating feedwater heaters in event of leaks, and transferring boiler feed pumps from one unit to another can be done remotely.

The station has two public-address systems supplementing normal telephone service, one for the coal-handling plant and another for the station generally.

The new station is located in a suburban area that has an adequate distribution system for its local load. Therefore no station bus at generator voltage is required and all power will be fed directly into the two 69-kv transmission systems. This is done for each unit through two transformer banks, each consisting of three 13.2–69-kv single-phase transformers with a combined forced-air-cooled rating of 100,000 kva per bank.

All auxiliary power is supplied from the electric system except one turbine-driven boiler feed pump and miscellaneous small auxiliary turbine-driven oil pumps.

General station auxiliary power is supplied from the 69-kv system. One 10,000-kva transformer is connected to each ring bus.

The auxiliary power system consists of five 4160-volt substations and ten 208-volt substations. One 4160-volt substation supplies large station auxiliaries and also the six 4000/208-volt substations for station lighting and miscellaneous small power. Two 4160-volt and two 208-volt substations serve the power requirements of each generating unit.

Lower sections of the outer walls are architectural concrete and upper sections are fluted aluminum panels. The metal walls are prefabricated, double-sheet construction with 16-gage striated aluminum on the outside, 18-gage zinc-coated steel sheet inside, and $1^1/_2$ in. of insulating Fiberglas between. Supplied in approximately 2 ft × 12-ft panels, the panels were welded directly to building steel. Window sash and ventilating louvers are aluminum

Electronic Control System

INCREASED centralization of automatic control places more responsibility on fewer operators, and on the control system. The use of an electronic link—connecting master to actuator—eliminates this ever-increasing distance problem created by centralization. Republic Flow Meters Company has, therefore, developed an electronically operated master-control system for combustion and process control applications. Called telemaster, the new system provides many new automatic control features such as: Complete freedom of control centralization, simplified and smaller control panels, elimination of transmission lags, greater accuracy and speed of response. The telemaster combines the null-balance principle of detection and the electronic transmission of control information to form a highly responsive control system that is reported to be remarkably fast in completing adjustments—regardless of the distances involved. The new system operates on a null-balance principle with a constant checkback between the initial input and final output, with no intervening mechanisms to cause dead spots or lags.

Briefly, the Telemaster operates as follows: Each final control element is remotely "linked" to its master by an electronic circuit similar in principle to an a-c Wheatstone bridge. Essentially, this electronic link consists of two voltage dividers or slide-wires connected through an amplifier. The "sender" slide-wire (comparable to two legs of a Wheatstone bridge) is

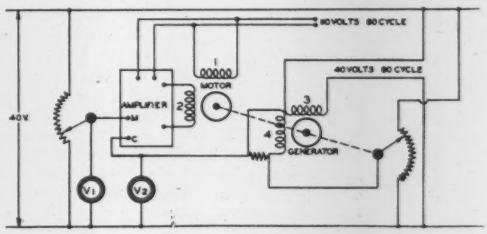

FIG. 3 CIRCUIT USED IN ELECTRONIC METER CONTROL SYSTEM

mounted on the master element; the "receiving" slide-wire (the other two legs of the bridge) is mounted on the actuator and controls the position of the final regulating unit, such as a damper or valve.

The wiper on the receiving slide-wire is driven to follow or repeat with precision the position of the wiper on the sending or master slide-wire. In other words, the final regulating element controlled by the receiver slide-wire, will assume the exact position dictated by the master. The Telemaster accomplishes this function by using the balanced bridge circuit. If the final control-element position does not correspond exactly to that dictated by the master, the bridge circuit is unbalanced. This unbalance is detected and amplified to drive the receiver slide-wire wiper to the new position commanded by the master. At the new position the bridge is again balanced, equilibrium is restored, and the command of the master has resulted in the proper corrective adjustment of the final control element position.

This description applies to the basic electronic link between the master and only one final control element. However, a number of final control elements may be electronically linked to follow the command of a common master, as is done in the conventional combustion-control or process-control application.

Early Rocket Research

THE rapid growth of rocketry in recent years is due in no small measure to the contributions of such men as Robert H. Goddard and the small bands of enthusiasts who formed the nuclei of the rocket societies in the twenties and thirties. They not only worked out a considerable portion of the basic theory, they also solved many of the vexing practical problems that invariably arise in this type of pioneering development. What legacy of knowledge and experience did these men inherit when they took up their work? The answer is to be found in the early history of rocket research which Joseph W. Siry traces in an article in the November, 1950, issue of *The Scientific Monthly*. Mr. Siry is acting head of the Theoretical Analysis Section of the Naval Research Laboratory's Rocket-Sonde Research Branch.

According to Mr. Siry the discovery of the pyrotechnic composition was probably the first addition to human knowledge that may properly be considered as forming part of the history of rocket research. It is now generally agreed that Greek fire was such a mixture. It was composed of sulphur, pitch, resin, and crude saltpeter. The armies of Alexander the Great were among the first to feel the effects of this strange new substance.

The second milestone was the invention of the aeolipile, which took place about 200 years later. The first aeolipile, built by Hero of Alexandria during the second century B.C., was a jet reaction device operating somewhat like the familiar lawn sprinkler.

It was in east-central China more than 1000 years later that these two basic notions were combined in the form of the first actual rocket. Speculation as to how it was created has given rise to the following general picture of what probably happened.

The first rocket evolved from the fire arrow, a standard item in the arsenals of the early Christian era. In casting about for a better fuel, it was recalled that the addition of salt to burning materials gave a brighter flame. If the flame were brighter, it should also be more persistent, according to the logic of those times. In inland regions such as central China, saltpeter is often more common than sodium chloride; hence the substance actually added was probably saltpeter, just the ingredient needed to make a pyrotechnic mixture. The proportions were almost certainly not stoichiometric. The burning rate was therefore probably fairly slow, slow enough to make the composition better suited for use in rockets than in guns.

This succession of fortuities was crowned by a modification to the arrow itself. To shield the flame from the wind, it is likely that the military engineers enclosed the front and sides of their pyrotechnic mixture, perhaps with a joint of bamboo. Thus the first rocket motor was born.

EARLY POWDER ROCKETS

The Chin Tartars were evidently the first to actually use these fire-arrow rockets. The occasion was the defense of their temporary capital against the Mongol hordes of Ogdai, son of Ghengis Khan. The siege took place in A.D. 1232 at Kaifeng, the capital of the Chinese province of Honan. The city fell, and one can well imagine that the Mongols went to special pains to learn the secret of this terrifying new weapon. Apparently they succeeded, for when Bagdad was attacked by the Mongols in 1258, similar equipment was used.

An Arabian manuscript prepared by Hassan Alrammah in 1280, gave formulas for making gunpowder and instructions for building rockets, which were called Chinese arrows, indicating that the Arabians had also solved the problem.

Knowledge of these things had also traveled more or less simultaneously to Europe. Rockets and rocket powders were mentioned in the "Liber Ignium," which was authored or translated by Marcus Graecus in the first half of the thirteenth century. The chronicle of Cologne on the Rhine spoke of rockets in the year 1258. The rocket proved to be the decisive weapon in the battle for the Isle of Chiozza in 1379. A defending tower was not overcome until it was set afire by a rocket.

Several variations of rockets existed at the beginning of the next century. In his "Bellifortis," which was completed in 1405 Konrad Kyeser von Eichstädt wrote of floating rockets, rockets traveling along guiding strings, and skyrockets, i.e., rockets that were launched vertically. The string-guided versions were evidently used for communication purposes. Kyeser also was the first to refer to the practice of boring a hole in the center of the powder charge to increase the burning area. This was a fundamental advance in rocket construction. It was the first step toward what is now known as the unrestricted-burning rocket.

Many applications of rockets were given by the Italian engineer Joanes de Fontana in his "Bellicorum Instrumentorum Liber," which was completed in 1420. Among them was the first design for a rocket car. The drawing showed an exhaust nozzle that may have been a forerunner of the modern De Laval nozzle.

By the sixteenth century most of the variations of the powder rocket were known, and designers had begun to turn their attention to auxiliary matters. Rockets equipped with small parachutes were described for the first time in this period. Thought was also given to the important problem of stabilization. The traditional stick was discarded in favor of stabilizing fins for the first time in designs that appeared about the year 1550.

The rocket was but one of the many weapons of war in existence at that time. Guns, which had been known since the early fourteenth century, had rapidly developed to the point where they were more than a match for the rockets of 1550. As a result, rockets were gradually superseded as weapons except in naval warfare, where they continued to be used as a means for setting fire to riggings. A Prussian colonel named Geissler attempted to use the rocket for a similar purpose in land warfare. He experimented with rockets that weighed 120 lb and carried a slow-burning incendiary bomb. The tests,

which took place near Berlin in 1668, were discontinued when it was decided that the rockets were unsafe.

DISPLAY ROCKETS

Although the rocket fell into disuse as a weapon, it did not disappear from the scene entirely. On the contrary, Mr. Siry points out, rockets began to achieve wide popularity as a feature of almost every major celebration in the seventeenth and eighteenth centuries. The displays conducted by the Italian school became famous throughout the world during this period. The Ruggieri family of Bologna traveled to many European capitals, bringing with them not only brilliant displays but also the term rocchetta. This is a diminutive form of the Italian work for distaff, an object that resembles the stick rocket in general appearance.

This period was not without fruit from the rocket-research standpoint. The step rocket was evidently first thought of at the end of the seventeenth century. It consisted actually of two rockets mounted and operated in tandem. The after, or lower, rocket was fired first and, when it was spent, the forward rocket was ignited. The purpose then was to make a more spectacular display; today the same method is used to gain greater altitude.

While the Europeans were engaged in increasing the size and splendor of their rocket displays, an Indian, Prince Hydar Ali Cawn of Mysore, was busy trying to reapply the rocket to warfare. His efforts were not without success, for he used rockets with good effect against the British in fighting along the Coromandel Coast from 1780 to 1784. His army boasted a rocket corps of more than 1000 men. The rockets were similar to the ones used in England for celebrations. They were much larger, however, weighing from 6 to 12 lb. Their bamboo guiding sticks were 10 ft long. The cardboard case used in display rockets had been replaced by an iron one. These rockets had a range of about 2500 yd. They were not too accurate, but they were very effective when fired in large numbers against the British cavalry.

The rocket corps was soon expanded to 5000 men, and the rockets themselves were improved by the addition of an explosive warhead. The British met these improved weapons at Seringapatam in 1799.

THE CONGREVE PERIOD

All this was not without its effect in England. Colonel William Congreve took up the challenge, and it is his name that is associated with this era of rocket research. Rocket development had been progressing in India for a quarter of a century when Congreve began his experiments in 1801. His contribution was to increase the size, variety, and effectiveness of rockets, and to put them in the hands of a European military establishment. Their use by the British in many of the major engagements of the time resulted in their being known, copied, and studied by all the leading nations.

Congreve began by investing his own money in the largest display rockets then available. He determined that the range of these missiles was about 500 yd. With the aid of his father, who was comptroller of the Royal Laboratory at Woolwich, Congreve obtained permission to use that laboratory's facilities. He soon increased the range of his rockets to about 2000 yd, and in 1805 he was able to conduct a successful demonstration for the Prince Regent.

Characteristically, the British first made use of these rockets as a naval weapon. The target was Boulogne, one of the points at which Napoleon had gathered his forces for a cross-Channel invasion of Great Britain. The attacks made in the fall of 1805 were ineffective. A second attempt, made a year later, was much more successful. Eighteen small craft were able to fire 200 rockets in salvos in about 30 min. The range was a little less than 1000 yd. The fires set by the rockets destroyed a considerable part of the city and its concentration of military equipment.

The success of this raid evidently spurred the Royal Navy to make large-scale preparations, for by the next year it was able to launch more than a hundred times as many rockets at Copenhagen.

The British Army also took up the new weapon. Rockets helped to defeat Napoleon at the crucial battle of Leipzig in 1813, and they were used against him in most of the engagements that followed.

Rockets were quickly adopted by almost every country on the Continent. They were used not only by the home forces but also in overseas and colonial warfare.

Congreve rockets even found their way into the western hemisphere. They were used as a surprise weapon in the battle for Washington that was fought at Bladensburg, Md., in 1814. They evidently had the intended effect, for the British won the battle and entered the capital.

It was less than a month after the burning of Washington that the celebrated battle for Baltimore's Fort McHenry took place. The rockets immortalized by Francis Scott Key in "The Star Spangled Banner" were Congreve rockets. The American Army was not immune to the rocket fever, and in time the new weapons were made part of its battle equipment.

This widespread interest in rockets was naturally accompanied by a great deal of research activity. Congreve had continued in his own efforts toward improvement. Noticing that the side-mounted guiding stick impaired accuracy, he moved it to the axis of the rocket and reduced its length from 25 to 15 ft. This was made possible by fitting the rocket with a base plate. The guiding stick screwed into the center of the plate, and the gases escaped through four conical holes around its periphery. In some models a fork with three or four prongs was used to attach the stick to the rear of the rocket. Congreve developed a wide variety of rocket types, ranging in size from 12 to 42 lb. The larger rockets each carried a 12-lb bomb and had a range of 3000 yd.

An American named William Hale, in 1846 discovered an effective alternative to the stabilizing stick. Hale installed three curved vanes in the orifice of the rocket motor. The jet, acting on these vanes, caused the rocket to spin, and the gyroscopic action provided the necessary stabilization. This principle is still in use today. Hale rockets were adopted by the American Army, by the British for colonial warfare, and by the Austrians for use in the Alps.

In spite of these improvements, rockets were soon to be far out-performed by guns. The principle of gyroscopic stabilization, however, was applicable to shells as well as to rockets. Rifling greatly increased the accuracy of gunfire. Chemistry provided the powerful new smokeless powders which progress in metallurgy made it possible to exploit adequately. Thus for the second time the war rocket was eclipsed by the gun.

Rockets meanwhile had begun to play quite another role, that of saving lives. They were used to run lines to vessels foundering in coastal waters. The early attempts were often handicapped, however, by the limited range of the rockets. In 1855 Colonel R. A. Boxer developed a rocket of much greater range by employing the step principle. His work was done at the Royal Laboratory, Woolwich, where Congreve had experimented half a century before. Boxer's two-stage line-carrying rocket was put into service at coastal stations, where it provided the crucial increment of range in many rescue efforts. In the years that followed, line-carrying rockets saved more than 12,000 lives in English waters alone.

During the nineteenth century the general interest in the

problem of flight led to several suggestions for the use of rocket propulsion as a means for powering aircraft. Most of these schemes envisioned the use of steam jets or of an apparatus similar to a swiveled machine gun firing blank charges. P. E. Paulet, a Peruvian engineer, carried on a series of experiments with a small pulse-jet combustion engine from 1895 to 1897. His motor, which was fueled with nitrogen peroxide and gasoline, developed a thrust of about 200 lb. It was apparently the first reaction engine to rely entirely upon liquid fuels. Paulet went no further, however, and it was not until 30 years later that he published the account through which his work became generally known.

The rockets in use at the end of the nineteenth century were similar in many important ways to those developed hundreds of years earlier. They were driven by powder fuels and, judged by present-day standards, they were not very efficient devices. The dramatic developments that have become synonymous with rocket research did not begin to unfold until the first half of the twentieth century

Altitude Record

A NAVY Viking rocket fired recently at the Army White Sands Proving Grounds, Las Cruces, N. Mex., soared to an altitude of 107 miles, establishing a new altitude record for American-built single-stage rockets, according to the *NOL Report*.

At the point in its trajectory when its fuel supply of liquid oxygen and ethyl alcohol had been exhausted, the $5^1/_2$-ton 50-ft-long upper-atmosphere research vehicle was traveling at a speed of better than one mile per second, Capt. A. E. Uehlinger, U.S.N., officer in charge of the Navy unit at White Sands, reported.

It was the fifth of ten Viking rockets which are being built and launched under a long-range development project of the Naval Research Laboratory.

Viking number four, fired from the deck of the U.S.S. *Norton Sound* in mid-Pacific on May 11, 1950, held the previous American record with an altitude of 106 miles.

Viking number 5 carried scientific instruments to gather new information on the density and nature of the ionosphere, which lies far above the stratosphere. Such data have a bearing on the propagation of radio waves and are expected to be of benefit in radio communications. In addition, atmospheric pressures were measured up to the peak altitude of the rocket and solar x-radiations were measured by various techniques, including photography.

Most scientific information obtained from this recent firing was sent back during the flight to a ground radio station by means of a radio telemetering system designed by the Naval Research Laboratory. Thirty channels were used to send continuous automatic signals to the ground station bearing information on the rocket's flight characteristics, motor performance, missile aspect, and the upper air.

The Viking is the largest American-built rocket for upper-atmospheric research. It can carry a maximum pay load of 1500 lb, although Viking 5 carried less than 700 lb. Its engine can develop a thrust of 20,000 lb for over a minute.

A German V-2 rocket fired at White Sands on Dec. 17, 1946, reached an altitude of 114 miles, it was recalled. A two-stage rocket missile, a combination of the German V-2 and the Army's smaller WAC Corporal rocket, ascended to more than 250 miles at White Sands on Feb. 24, 1949.

The Viking was designed and developed by the Naval Research Laboratory, the Glenn L. Martin Company, and Reaction Motors, Inc.

Railroad-Car Refrigeration

THE results of two years of tests and several months of commercial operation with a mechanical method of railroad-car refrigeration has indicated the clear superiority of mechanical refrigeration over the dry-ice or ice-and-salt method, according to a statement made at a recent press conference by Joseph A. Numero, president, U. S. Thermo Control Company of Minneapolis, Minn.

Fruit Growers Express Company, Western Fruit Express Company, and Burlington Refrigerator Express Company, are currently using such a gasoline-powered refrigeration unit developed by U. S. Thermo Control under the trade name "Thermo King." With 6 in. of insulation, controlled temperatures from —20 to +80 F ± $1^1/_2$ F are maintained by simply setting a dial on the equipment.

More than 250,000 miles of rail travel have been "logged" by railroad cars equipped with Thermo-King, without loss of a single pound of perishable cargo, Mr. Numero reported.

Cargoes preserved by the system have ranged from apples, oranges, strawberries, and potatoes to meats, fish, canned fruits and vegetables, frozen concentrated fruit juices, and frozen fruits and vegetables. Commercial runs have been made successfully over the rail lines of both the United States and Canada under all weather conditions, official performance reports show.

The Thermo-King system for railroad cars comprises two

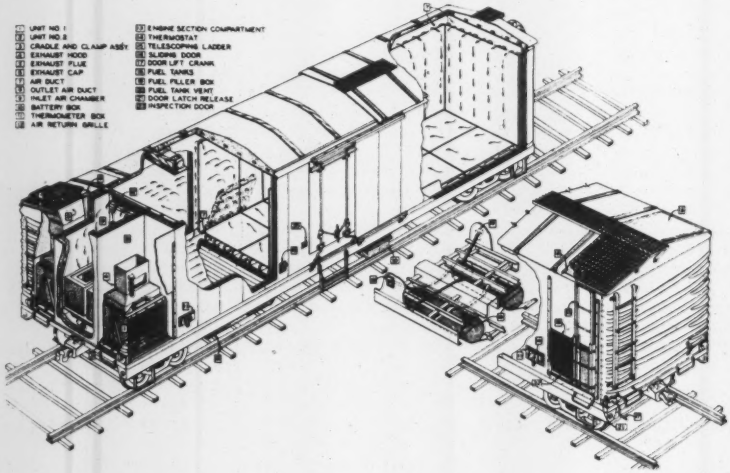

FIG. 4 THERMO-KING REFRIGERATING AND HEATING SYSTEM FOR RAILROAD REFRIGERATION CARS

FIG. 5 REFRIGERATION UNIT SHOWN IN PROCESS OF INSTALLATION IN A REFRIGERATION CAR

identical self-contained units installed in a compartment at one end of the car. Each unit consists of a 28-hp water-cooled gasoline engine, 6-cyl compressor, cooling coil, air-circulating fan, and controls. Freon is used as the refrigerant.

The most important feature of the system is that each unit is a complete package. It can be removed and a new one installed in ten minutes. Thus with a few spares or replacement units placed at various Division points along the line, one mechanic can take care of 3000 miles of track. For each unit there is a slide-drawer type of mounting base firmly anchored to the car. When a unit is to be installed, this base is pulled outward and the unit is placed on it. Two simple connections are made for fuel and automatic controls, then the unit is pushed into place. By turning a crank at the end of the car the front screen is lowered into position and at the same time the exhaust chimney is lowered and clamped to the top of the unit. The chimney carries off fumes and heat from the engine section.

The floor racks and wall flues of the car serve as ducts through which air delivery is made. Floor racks have a solid surface extending full width and length of loading space, forming a continuous floor duct. Air is forced downward through the cooling coils, under the floor racks, up through the side and end-wall flues, and over the top of the load for return to the cooling-coil chamber for recirculation. To eliminate uneven temperatures and stratification of the air during the "off" period of unit operation, a small battery-powered electric fan is provided which is located at the bottom of the cooling-coil chamber. It automatically starts when both refrigerating units stop operation.

For precooling, both units are in operation, but after the empty car is cooled to the temperature level at which the temperature control is set, one of the units will protect the load thereafter. The automatic controls are so devised that the second unit will begin to operate in the event that the first unit becomes inoperative.

The tandem railroad installation has an approximate capacity of three tons of refrigeration at zero deg F. One unit in operation is sufficient to maintain zero degrees in the car.

Each unit is equipped with an automatic or time-regulated defrosting device which goes into operation every five hours.

In addition to providing refrigeration, these same units will automatically provide heat. If the outside temperature falls below the temperature being maintained in the car, the units will automatically operate on the heating cycle. Operating tests demonstrated that the Thermo-King will maintain correct commodity temperatures in those instances where a load travels from one climate to another.

A system of signal lights and thermometers is installed at both sides of the car so that a glance at either side of the car will tell the operating condition of both units.

Two fuel tanks, of 155 gal capacity each, are located under the car. This is more than ample supply for a cross-country trip. Batteries for each unit are housed in boxes at each side of the car. The batteries are kept charged by the generator in the unit.

In addition, another development of prime importance to shippers was revealed at the press conference by Frederick McKinley Jones, chief engineer of the U. S. Thermo Control Company.

That development is in the field of humidity control, a refinement of the mechanical-refrigeration process that is expected shortly to enable shippers of such products as lettuce and strawberries to avail themselves of the advantages of mechanical refrigeration. It will eliminate top and body icing, and prevent slime, mold, wilting, and dehydration.

Mr. Jones's invention involves a system of dampers that seal off the cargo compartment and stop the fresh produce from "breathing." These dampers do not swing into sealing position until moisture brought out by the preliminary cooling process has been carried away.

But once the product has attained the desired coolness, the "lid" goes on and the refrigerated air, for the remainder of the haul, is confined to the cold wall that envelops the car. To prevent stratification, a small auxiliary fan circulates air within the cargo space.

The humidity control device, likened to the "crisper" compartment in a home refrigerator, will eventually become standard equipment on Thermo-King units for both railroad cars and trucks, Mr. Jones announced.

Gas-Turbine Locomotives

TEN gas-turbine-electric locomotives for regular freight service have been ordered from the General Electric Company by the Union Pacific Railroad, according to A. E. Stoddard, Union Pacific president. They will be similar to the 4500-hp unit which has been undergoing test on regular freight runs of the Union Pacific for the last year and a half. (See MECHANICAL ENGINEERING, issues of July, 1949, pages 591–594 and May, 1950, pages 406–407.) Delivery is expected to begin in the latter part of 1951 and, Mr. Stoddard said, will permit the Union Pacific to "evaluate more fully, under a wider variety of operating conditions, the potentialities of this new type of motive power."

"On the basis of results to date, the gas-turbine-electric locomotive looks promising as an addition to steam and Diesel-electric power," Mr. Stoddard added. "Tests to date have been most encouraging."

General Electric will build the Alco-G-E locomotives at its plant in Erie, Pa.

The Union Pacific locomotives will be geared for freight service and will have a top speed of 65 mph. Unlike the de-

velopmental unit, which has an operating cab at each end, the new locomotives will have a cab at the front end only.

The new locomotives will be 83 ft, 7½ in. long over knuckles, 14 ft, 3 in. high over the roof sheets, and will negotiate curves of 228 ft radius. The running gear will consist of four two-axle trucks, with each truck equipped with two traction motors. The weight will be approximately 253 tons.

The latest report on performance of the developmental unit on the Union Pacific reveals that it has operated nearly 80,000 miles in regular freight service and handled 285,800,000 gross-ton-miles. The turbine power plant has been in operation nearly 5000 hr.

Long-Range Jet Airliner

WITH the De Havilland Comet jet airliner proved, in production, and scheduled for service in 1951, plans announced for a more powerful version open up the prospect of jet travel on the world's longest air routes. The new version of the Comet could fly these long stages in hours less than the time taken by propeller-driven types.

The present BOAC version of the Comet was never intended for long-distance nonstop runs like that across the Atlantic. In the more powerful version, the Ghost centrifugal type of engines will be replaced by axial-flow types to give it greater speed and range. The axial type of gas turbine has a larger compressor and better fuel consumption than the centrifugal engine.

Two types of these powerful axial-flow jet engines are being built in Britain. One is the Armstrong Siddeley Sapphire of 7200 lb thrust. This engine was recently bought by Curtiss-Wright, who will manufacture it under license. The other axial engine is the Rolls-Royce Avon whose top power is still secret. The Avon is at present in production for the English Electric Canberra jet bomber.

With four of these engines, each with 7000 lb thrust, replacing the 5000-lb-thrust Ghosts, the increase in the Comet's performance will be considerable. The aircraft will have nearly 50 per cent more power, with consequent improvements in speed. This increase in speed will tell on the range of the Comet—it will be able to fly farther in a given time. And since the axial type of turbine is also known to have an improved consumption over the centrifugal type, the new engines will mean even greater range.

Experimental plans have also been made to carry several more hundred gallons of fuel in tanks fitted in the leading edges of the wing. The result is a long-distance Comet which could take over the world's longest air stage lengths, flying nonstop transocean stages from continent to continent. On some of these routes it could halve the time taken by present-day airliners. On the Atlantic run, for example, a westbound present-day airliner, flying against head winds, takes about 18 hr from London to New York. The long-range Comet would probably take less than nine. Flying east, this new Comet would probably cut the flight time from 12½ hr to less than seven.

Petroleum Industry

FOR the fifth consecutive year the domestic petroleum industry has scheduled the investment of more than two billion dollars for development, modernization, and expansion of its facilities in this country.

This is equal to $14.50 for every man, woman, and child in the United States.

On the basis of a survey, Frank M. Porter, president of the American Petroleum Institute, estimated capital expenditures of the nation's oil companies during 1950 at $2,400,000,000. Of this, all but $228,000,000 was earmarked for domestic facilities.

The $2,172,000,000 in 1950 raises the industry's postwar domestic investment total (1946 through 1950) to an estimated 10 billion dollars. If American expenditures overseas are counted in also, the over-all total exceeds 12 billion dollars.

The domestic capital expenditures scheduled during 1950 was only slightly less than the record-breaking outlay of $2,300,000,000 made by the industry in 1948 to meet increased public demand for its products and services.

As in past years, the expenditure for production operations—searching for and developing necessary oil and natural-gas reserves and supplies—accounted for more than half of the capital outlay. In 1950, approximately $1,360,000,000 was spent in this branch of the industry, compared to $1,457,000,000 in 1949, and a 1946–1949 average of $1,341,000,000.

Investments for refinery facilities in 1950 were close to $394,000,000, much of the money going into the latest-type cracking plants for producing vital high-quality products for domestic requirements and possible military needs.

Transportation estimates totaled $324,000,000, the major portion of which was scheduled for pipe-line construction work, as follows: crude-oil lines, $120,000,000; product lines, $74,000,000; and natural-gas lines, $91,000,000. The outlays planned for natural-gas lines by the oil industry in 1950 contrast with expenditures of $49,000,000 in 1949, and a 1946–1949 average of $41,000,000 annually. Product pipe-line expenditures likewise are increased sharply from the $31,000,000 invested in 1949 and the four-year average of $41,000,000 a year.

The industry's efforts to modernize, improve, and expand its marketing facilities—the segment of the industry closest to the public—are expected to result in a record-high capital investment of $281,000,000 in that field. This compares with $233,000,000 spent in 1949, and an annual average of $247,000,000 over the 1946–1949 period. Investments for marketing facilities mean more efficient and more dependable service to the oil-buying public.

In a recent statement the API president pointed out that as a result of the unprecedented industry expansion in postwar years, the oil industry's crude production capacity has been increased 27 per cent, its refining capacity 21 per cent, and the nation's proved crude-oil reserves 24 per cent.

New Oil-Shale Process

PILOT-PLANT tests indicate that a new continuous process for extracting oil from oil shale, developed by Bureau of Mines engineers, may provide the most efficient and economical method of producing shale oil to date, Secretary of the Interior Oscar L. Chapman said recently.

During a 10-day test run at the Bureau's oil-shale mine and plant at Rifle, Colo., a pilot-plant retort utilizing the new process, known as the gas-combustion process, achieved a high recovery of liquid oil and demonstrated high capacity. The oil yield during the test run averaged about 95 per cent of the Fischer assay value of the shale treated, and the retort handled some 200 lb of shale an hour for each square foot of bed area.

Secretary Chapman described the process as simpler than others previously tested by the Bureau. Further tests will be made and larger-scale studies will be carried out to determine its worth as a commercial process.

The new process utilizes a vertical retort which is continuous in operation. Raw shale is fed into the top of the retort and moves downward by gravity against an upward current of hot

gas, which is drawn off near the top of the retort and passed to a recovery system. As the downward moving shale and the rising gas pass each other, the shale is heated and the gas is cooled, which results in high thermal air. Additional heat is supplied by burning part of the preheated gas with air.

The gas-combustion process is expected to be economical compared with others thus far tried, because the retort is simple and of high capacity relative to its size. The need for external heat exchangers, such as are used in the gas-flow process, for pebble stoves such as are used in the Royster process, and for water-cooled condensers is eliminated. In addition, the process requires a relatively small recovery system, because the oil-laden gas is effectively cooled in its upward journey through the incoming shale.

Lignite Research

TO spearhead the way for greater use of the nation's enormous lignite reserves, a new $750,000 Bureau of Mines lignite research laboratory at Grand Forks, N. Dak., has been built and is ready for occupancy.

Built exclusively for lignite research, the new building provides excellent facilities for studying methods of increasing the use of lignite for power, heat, and other purposes for further development of the Great Plains and nearby states.

Research in the new laboratory will include studies in preparing and drying lignite—a low-grade coal with a high moisture content. Development of effective ways to steam-dry lignite should upgrade the products and expand the commercial market for lignite. The great demand for dried lignite is expected to come from new power plants in the upper Midwest.

Practically untouched, lignite reserves in the United States are estimated at 939 billion tons. Containing 600 billion tons, North Dakota mines 96 per cent or nearly 3 million of the nation's yearly production. Eastern Montana also has about 315 billion tons of lignite.

The three-storied pilot plant in the new building, where lignite is experimentally gasified, is completely separated from the administrative-laboratory wing by expansion joints designed to prevent damage from temperature expansion or settling. It has structural-steel framing, cement-block walls, and a steel deck roof.

Any type of large-scale experiment can be conducted in this pilot plant which offers ample space for equipment and future projects. A big crane that eliminates the use of an elevator to the second-story level can carry as much as five tons of equipment to any spot in the plant for assembly. Trap doors in the floor are equipped with automatic guards for constant protection at hatch openings. A machine shop opens into a carpenter shop in the administrative-laboratory wing.

Synthetic Fibers

THE recent phenomenal rise in prices of wool "tops" to an average of $3.50 per lb, plus improvements in processing and using synthetics, have accelerated previous trends to blends and substitutes for wool, it is reported in the *Industrial Bulletin* of Arthur D. Little, Inc., for December, 1950. More than half the men's summer suits produced in 1950 contained rayon, alone or combined with other fibers, and rayon is now well received in middle-weight year-round suitings, blankets, boys' clothing, and carpets. All-synthetic fibers, made entirely from chemicals, such as nylon, Acrilan, Orlon, Dynel, and Fiber V, may be used alone or may be blended with wool to impart such characteristics as crease-resistance and washability at prices acceptable to the ultimate consumer.

Several of the all-synthetic fibers can be made with a fluffy pile said to be as warm and soft as wool. All-Orlon sweaters which resemble cashmere are available, while nylon staple is excellent for wool-like socks. Blankets made from Dynel are soon to be placed on the market; they are mothproof, virtually shrinkproof, and could be laundered at home and dried in less than two hours. Since these new fibers cost only $1.25 to $1.90 per lb, their use alone or blended with wool promises to help hold textile and clothing prices to a reasonable level.

Another new fiber, called Vicara, is made from corn protein and is as soft as cashmere. At 83 cents per lb, Vicara has a heavy price advantage over cashmere at about $12 per lb, when a larger proportion of Vicara is used in blending with other fibers. Although it is usually not used alone, Vicara is frequently blended with wool for sweaters, socks, or dress goods, and with acetate rayon for men's flannels. Both Dynel and Vicara are usually not pure white, and must be bleached before they can be dyed in pastel colors. Many of the new fibers, such as Orlon and Fiber V, which is at the consumer-testing stage of development, appear to offer many advantages when blended with wool, such as improvement in wrinkleproofing and washability, but they are still too scarce to be an answer to rising wool prices.

Like nylon, several of the new fibers are all-synthetic. Orlon, Dynel, and Acrilan, which is in the pilot-plant stage, are made from a compound called acrylonitrile, derived from natural gas, petroleum, or acetylene. During the wartime peak, special-purpose synthetic rubber took about 12 million lb of acrylonitrile annually, but the new fibers have pushed demand to about 20 to 25 million lb a year. New acrylonitrile plants are being built in Texas and West Virginia, and some forecasters predict total production of 100 to 300 million lb annually within the next decade. Fiber V is another all-synthetic fiber. Developed in England, where it was called Terylene, it is derived from terephthalic acid, a petroleum derivative, and ethylene glycol, which is also used for antifreeze. A plant to produce 30 million lb of Orlon staple annually is now under construction in South Carolina and a large new Acrilan plant is going up in Alabama.

Rayon, which goes back to wood or cotton linters for cellulose, has done much to keep apparel prices from matching wool's increases. Rayon staple, or cut-up fibers, distinguished from continuous filaments, sells for 42 to 48 cents per lb.

For the large market for floor coverings, special rayon fibers have been developed to be used either alone or blended with wool. One is a crimped viscose staple with a dull finish, which produces a firm surface, dyes well, and makes long-wearing carpets. Another crimped rayon fiber combines characteristics of both acetate and viscose, and several manufacturers are combining it with wool.

One leading manufacturer will devote over a quarter of its 1951 production to coverings containing synthetic fibers; four lines will be made from rayon-wool blends, and a fifth will be all rayon. Rayon staple for carpets costs 42 to 48 cents, as compared with $1.35 for carpet wool.

Anaerobic Permafil

A MATERIAL called "anaerobic permafil," which remains liquid as long as a stream of air bubbles through it, but which hardens in a few minutes when away from air, has been developed in the chemistry divisions of the General Electric Company Research Laboratory. Its properties are thus opposite to those of paint, which hardens when exposed to air.

According to reports, this new material is able to penetrate extremely small cracks before hardening. Thus a possible application is a tight seal for stopping nearly invisible leaks, or a "pipe dope" for sealing threaded unions.

The term anaerobic which means "nonairliving" was coined by Louis Pasteur. It is used by bacteriologists to designate organisms that remain inactive in the presence of air, but which thrive and propagate when air is absent.

Anaerobic permafil is the latest in a series of related compounds called "permafils," which the G-E chemists have developed. Originally they were called "solventless varnishes." Ordinary varnishes contain some solid resin dissolved in a liquid solvent. When applied to a surface the solvent evaporates and the varnish remains as a hard layer.

Anaerobic permafil remains liquid as long as it is aerated. When away from air it solidifies quickly, without heating, or adding catalysts and accelerators.

When two metal strips are coated lightly with it and clamped together the joint will support ten pounds after ten minutes. After 20 hours it will hold 100 lb. If still faster hardening is desired, the permafil may be heated, up to 212 F, and solidification takes place in a minute or less.

The chemists found that certain metals, such as copper, iron, and silver solder, exert an accelerating action on the hardening process, even at room temperature. Therefore they can be sealed more quickly than surface of glass and mica, which are inert; though they, too, can be tightly fastened. Paper and fabric also may be bonded to themselves and to other materials.

One proposed use of anaerobic permafil is to eliminate the lock nut needed to hold another nut tightly on a bolt. A few drops are placed on the threads of the bolt just before the nut is screwed on. The plastic hardens so tightly that considerable force is required to remove the nut.

Another use is for sealing against leaks. The permafil may be applied to threaded joints in pipes, where the liquid penetrates into the crevices and then hardens. Also, if painted on porous castings, it enters the pores and renders the casting airtight.

The new material is not yet available commercially though plans are being made to put it on the market at a later date.

Low-Power Nuclear Reactors

INFORMATION necessary to the design, construction, and operation of specified low-power nuclear reactors used for research purposes has been released by the governments of the United States, the United Kingdom, and Canada.

The three governments have determined that the release of this information will speed the training of nuclear-reactor engineers and technicians and will hasten atomic-energy development in these countries, particularly for peacetime applications. It was determined that this information would not aid rival nations in the development of military applications of atomic energy. Low-power research reactors cannot be used for producing atomic weapons or power.

The United States research reactors on which design and operation information will be considered for declassification are as follows:

1 The world's first nuclear reactor, constructed from uranium and graphite under the West Stands of the University of Chicago's Stagg Field in 1942, and subsequently dismantled.

2 A modified version of the West Stands reactor, located at the Palos Park site of the Argonne National Laboratory near Chicago.

3 Uranium and heavy-water reactor located at the DuPage County site of the Argonne National Laboratory.

4 A "homogeneous" enriched uranium, light-water reactor located at the Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

British and Canadian reactors affected by the revised declassification policy are "Gleep," a uranium and graphite reactor located at Harwell, England, and "Zeep," a uranium and heavy-water reactor located at Chalk River, Ontario.

The information now releasable describes what must be known in order to assemble and operate a low-power research reactor. Before such a reactor can be built by a private institution, however, the permission of the government to use the necessary fissionable materials is required. In the United States the governmental agency which controls the use of fissionable materials is the Atomic Energy Commission.

The newly declassifiable information will be useful largely in advanced courses in reactor physics. For example, it will now be possible for instructors to use specific data obtained from actual experiments, instead of discussing reactor technology in general and theoretical terms.

URANIUM-GRAPHITE NUCLEAR REACTOR

The rebuilt reactor looks very much like a large windowless, two-story, square, concrete building. Its external measurements are: 30 ft wide, 32 ft long, and 21 ft high. A small laboratory has been constructed on top of the reactor in which experimental work can be performed using radiation generated within the pile.

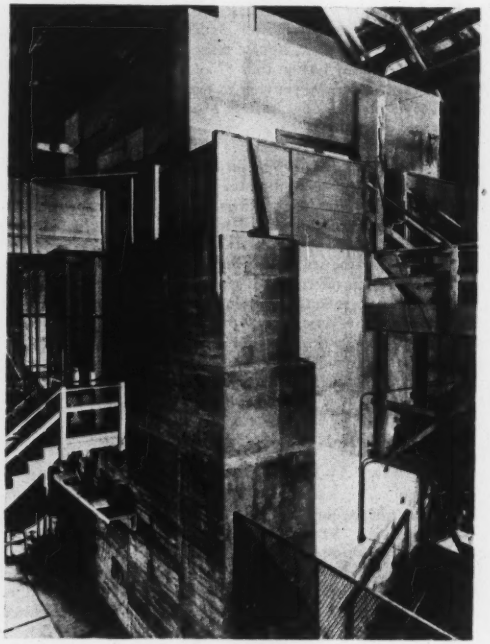

FIG. 6 VIEW OF THE CAST (LEFT SIDE) AND NORTH FACES OF THE NATIONAL LABORATORY'S URANIUM-GRAPHITE ARGONNE NUCLEAR REACTOR

Inside the five-foot concrete walls is the reactor core, a cube-shaped pile of graphite into which lumps of uranium have been embedded according to a predetermined lattice-type pattern. The top of the graphite-uranium pile is covered with 6 in. of lead and about 4 ft of solid wood.

The small experimental laboratory is constructed atop of this shield. Various controls and safety rods enter the sides of the reactor from supporting platforms built around the faces or sides of the reactor. Numerous openings are available in the front face of the reactor so that blocks of graphite, known as stringers, may be removed and test materials inserted into the active area of the reactor.

HEAVY-WATER REACTOR

In comparison with graphite moderated reactors, the heavy-water reactor is quite small. It consists of an aluminum tank, 6 ft in diam and 8 ft 10 in. high, which is filled with approximately 6½ tons of heavy water (amount contained in 32,000 tons of ordinary water) and into which are suspended 120 uranium metal rods, 1.1 in. in diam and 6 ft long. The uranium rods, whose total weight is nearly three tons, are arranged to form a square lattice with the distance from center to center being 5⅜ in. Heavy water, which is present in ordinary water as one part in 5000, serves to slow down the speed of the neutrons. Heavy water is more effective than graphite in slowing down neutrons and does not absorb neutrons as readily as does graphite. To remove the heat created in the fission process, the heavy water is circulated through a heat exchanger. Thus the heavy water serves not only as a moderator, but as a cooling agent as well.

The reactor tank rests on a 2-ft layer of graphite blocks supported by the concrete-pile foundation. The graphite reflects the neutrons to the reactor core. In addition to this neutron reflector on the bottom, the sides are provided with a reflector of equal thickness.

A 4-in. shield of lead-cadmium alloy surrounds the reflector and fits snugly against a thick concrete shield which encases the entire reactor. The lead-cadmium alloy protects the concrete from exposure to neutron and gamma radiation. A 1-ft shield of lead bricks is placed on top of the graphite reflector and is continued over the top plate of the reactor tank. Between the bottom of the lead cover and the top plate of the reactor tank is a thin layer of cadmium metal.

Neutrons escaping from the uranium section of the reactor are slowed down by collisions with atoms in the heavy water and are then absorbed by the cadmium shield. This absorption of neutrons causes the cadmium to emit gamma rays which are in turn stopped by the lead shield. (The capture of a neutron by any material immediately results in the formation and emission of a gamma ray.) Thus personnel during the loading and unloading of fuel are protected from neutrons by the cadmium and from gamma rays by the lead. The thick lead shield at the side and bottom contains copper tubing for circulating cooling water to remove the heat generated in the shield and in the graphite.

The space between the heavy water and the cover of the tank is filled with helium. This inert gas replaces ordinary air which would normally be present and which must be kept out of the system. Moisture in the air would be condensed inside the reactor tank and would dilute the rare and expensive heavy water. There is another objection to the use of air. Inasmuch as nitrogen makes up about four fifths of the atmosphere, radiation bombardment of air would result in the formation of nitric acid.

Two blower pumps circulate the helium through a cooler and through a catalyst chamber. These pumps, one of which is normally a stand-by pump, circulate the helium gas and dissociated heavy water. Under neutron bombardment heavy-water molecules break apart to form oxygen and heavy hydrogen and these gases are recombined in the catalytic chamber and returned to the reactor tank.

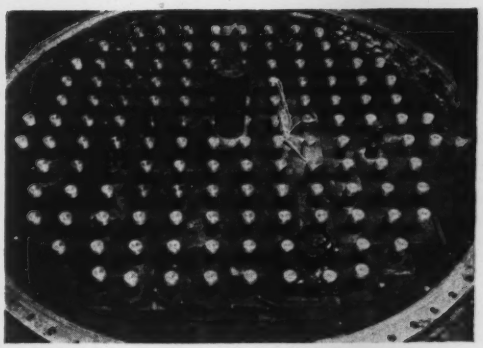

FIG. 7 TOP OF REACTOR CORE OF ARGONNE NATIONAL LABORATORY'S HEAVY-WATER REACTOR

LOS ALAMOS WATER BOILER

Basically, the water boiler, as developed up to January, 1950, consisted of a container filled with an enriched uranyl solution surrounded by a neutron reflector and necessary radiation shielding, with the necessary control rods to regulate the power level and a cooling system to carry off heat generated by the reaction.

The original water-boiler design for a low-power reactor (LOPO) was completed in November, 1943. It was decided to build this device before attempting the later model reactor of higher power. In the low-power unit the shielding and cooling problems were eliminated. At the same time its operation would indicate to what extent gases might be evolved from fission fragments and decomposition of the water and would reveal unforeseen difficulties in keeping the salt solution critical.

A separate building for LOPO was erected at a location remote from the main portion of the technical area at Los Alamos. Assembly proceeded through the spring of 1944, and the system became critical in May, 1944, with 1.2 lb of U-235. The highest power to which LOPO was run during its several months' existence was about 50 milliwatts, which raised the temperature to about 94 F.

The high-power reactor (HYPO) went critical in December, 1944, with about 1.8 lb of U-235, although the normal loading contains about 1.9 lb of U-235. Except for minor design changes, HYPO, as originally constructed, has operated successfully for several years.

The Los Alamos water boiler has been used primarily for physical experiments requiring a concentrated neutron source. It is the smallest and most economical type of chain reactor so far built. The peak power of HYPO was about 6 kw, representing a neutron flux of about 300 billion neutrons per sq cm per sec at the center of the reactor. A slow or thermal neutron flux of the order of one billion neutrons per sq cm per sec is available for research purposes in the graphite tamper surrounding the reactor.

The heart of the reactor consists of a 1-ft spherical stainless-steel container filled with a uranyl-nitrate solution in water, known to the Los Alamos scientists as "Soup." The uranium in the uranyl salt contains about 1 part of fissionable U-235 isotope to 6 parts of nonfissionable U-238 compared to ordi-

nary uranium which contains 1 part U-235 to 140 parts of U-238.

Surrounding the container is a reflector, or tamper, consisting of an inner core of beryllium oxide supplemented by a shell of graphite. The reactor and tamper occupy a cube about 5 ft on a side. A considerable amount of shielding is also necessary to protect operating personnel. The shield around the entire assembly consists of 4 in. of lead, $^1/_{32}$ in. of cadmium, and 5 ft of poured concrete.

At the front or working face of the reactor a square tunnel pierces the shield. This tunnel was plugged with graphite to form a graphite thermal column and a number of ports for experimental irradiations were placed in the column and the tamper. A 1-in. tube also extends through the shield, tamper, and through the reactor sphere itself. It permits materials to be irradiated at the highest neutron flux level.

Because of its low power, LOPO required no cooling system. In HYPO, however, a six-turn cooling coil of $^1/_2$-in. tubing and having an effective length of 157 in. is wound in the form of a helix inside the sphere. About 50 gal of water per hr is pumped through the cooling system, which is sufficient to permit year-round operation at 6 kw. After passing through the reactor, the cooling water is retained for a short time in a tank within the shielding to permit short-lived induced radioactivity to die down before it is released.

When operating, the water in the fuel solution is decomposed by the highly ionized fission products forming about $^1/_2$ cu ft of hydrogen and oxygen gas per hour. Since this chemical mixture is extremely explosive and also since highly radioactive gases are produced in fission, some means of diluting and flushing out these gases was required. This was accomplished by means of a double inlet-outlet tube welded to the top of the sphere. Air is pumped through the inner $^1/_4$-in. tube and is exhausted through the outer $^3/_4$-in. tube. The inner tube may be raised or lowered so that it acts as an indicator of the solution level. Also, by leading the gas from the outlet tube through test equipment, rapid analysis of the boiler gas may be made.

Copper-constantan thermocouples for measuring temperatures are placed in a tube extending into the center of the sphere and are also connected to the water inlet and outlet tubes.

HYPO is controlled by means of a cadmium shim rod, two cadmium control rods, and a cadmium safety rod. The latter always remains out during operation, since it is used only to stop the chain reaction in case the intensity should get too high. For additional safety, the two control rods are designed with a release mechanism so that they can stop as well as control the reaction. If both control rods and the safety rod are dropped at the same time, the neutron intensity falls 85 per cent within one second.

Under normal operating conditions the water boiler is self-regulating due to the temperature effect. As the temperature increases, the volume of the solution expands and the reactivity per unit volume declines. This automatically slows down the reaction so that under normal conditions it is impossible for the reactor to get out of control. If the control rods are pulled out too rapidly, however, the heat release could possibly be non-uniform through the solution. For very short times, say, $^1/_{50}$ sec or so, local hot spots might arise in which the solution would vaporize before the increased temperature had time to control the activity. In such cases the control rods would drop automatically to stop the reaction before serious damage to the reactor could occur.

The neutron flux is measured continuously by means of an ionization chamber, coated with U-235. The U-235 atoms in the coating undergo fission when hit by neutrons and the highly charged or ionized fission products can be detected by the chamber. The detection circuit leads into a very sensitive galvanometer in which the amount of electric current registered is proportional to the neutron flux. Independent U-235 chambers are used to trigger the safety and shim rods, which drop whenever a predetermined intensity is reached.

OTHER DATA TO BE RELEASED

More complete information on the design, construction, and operation of these declassified reactors is available from the Atomic Energy Commission, and a number of technical papers on these declassifiable low-power reactors are being prepared by the individuals who have taken part in this research in the United States, United Kingdom, and Canada.

In addition, certain data on the nuclear properties of uranium having significance in the design and operation of low-power reactors also will be released.

Of most general interest is the fact that the low-energy thermal neutrons are captured in appreciable quantities by U-235 without causing fission. It would be inferred from earlier studies of fission, that almost all thermal neutrons captured by fissionable U-235 would result in fission. However, it will reveal that a significant fraction of all thermal neutrons colliding with U-235 are captured to form U-236. Engineers designing uranium reactors must keep this fact in mind since these captured neutrons are not available to continue the chain reaction.

A more precise value for the number of neutrons produced on fission of U-235 by thermal neutrons will also be reported. This number hitherto has been quoted as between 2 or 3.

Other data to be declassified include a description of the energy distribution of the neutrons released instantaneously when U-235 is fissioned by thermal neutrons, and a formula showing how "lumping" the natural uranium in low power piles affects the capture of neutrons during their slowing-down process. All of these data are necessary for training nuclear-reactor engineers and in designing low-power research reactors utilizing uranium for their fuel.

Uranium Production

URANIUM to be produced in the Union of South Africa as a by-product of gold production will be sold to the United States and the United Kingdom under an agreement just concluded by the three nations.

The new agreement marks the successful culmination of several years of intensive research and development by the three nations on the problem of economically recovering uranium from the gold-bearing ores.

The South African gold ores represent one of the world's largest sources of uranium. Although the uranium content of the ores is small, potential production is relatively large because of the great quantities of ore mined.

The initial production will come from the properties of the following mining companies, although consideration will be given by the South African Government to the construction of additional uranium processing plants on other mine properties as it is warranted: West Rand Consolidated Mines, Ltd.; Daggafontein Mines, Ltd.; Blyvooruitzicht Gold Mining Company, Ltd.; and Western Reefs Exploration and Development Company, Ltd.

Funds to cover the capital cost of the uranium processing plants will be loaned by the United States and United Kingdom, on a banking basis, if requested by the South Africans.

Although uranium will be a valuable by-product of gold production, the revenue and earnings from uranium will not be on such a scale as to affect materially the financial positions of the companies concerned.

Negotiations which led to the new agreement were recently concluded in Johannesburg by representatives of the three nations. Preliminary discussions were held in the same city a year ago.

Plant design and construction leading to the production of uranium under the new agreement is proceeding on an urgent basis. Because of security considerations, no information on rate of progress or other aspects of the program can be made public.

U-235 Production Plant

THE U. S. Atomic Energy Commission recently announced that funds for a new U-235 production facility are included in the Second Supplemental Appropriation request now being considered by Congress. The site selected for the new plant is the Kentucky Ordnance Works, 16 miles west of Paducah, Ky. This location was found by the Commission and its consultants to present more advantages than any other examined. The site will cover about 5000 acres, a considerable part of which will be obtained through purchase.

The new plant facilities will further expand capacity for producing U-235 for use in weapons or in fuel elements for nuclear reactors.

A peak construction force of 10,000 workers may be required.

When completed, the new facilities will be operated for the Commission by the Carbide and Carbon Chemicals Division, Union Carbide and Carbon Corporation, which operates the Commission's major production facilities at Oak Ridge. Permanent employment by Carbide and AEC upon completion of the project may be as many as 1600 persons.

An area office, to be known as the Kentucky Area Office, will be established at the site after Congress passes the Second Supplemental Appropriations which includes funds for the plant.

Principal component of the facilities to be constructed will be a large gaseous-diffusion plant for the separation of fissionable U-235 from nonfissionable U-238. The new plant will supplement the extensive U-235 separation facilities now in operation or under construction at Oak Ridge.

The gaseous-diffusion process is one in which uranium-hexafluoride, in gaseous form, is pumped through thousands of extremely fine barriers which have literally millions of tiny holes per square inch. Since U-235 atoms are slightly lighter and therefore travel slightly faster, they strike the screens and pass through the holes with greater frequency than do U-238 atoms. In this process, the fissionable U-235 atoms, which make up only one part in 140 of natural uranium, are gradually separated and concentrated.

Operations of the plant will involve no appreciable radiation problems. In the five years the similar Oak Ridge gaseous-diffusion plant has been in operation, not a single employee has suffered a radiation injury.

Facsimile System

A TEST model of a new high-speed long-distance facsimile system, developed by RCA Laboratories, Princeton, N. J., under contract with the Atomic Energy Commission, has been installed at the Oak Ridge National Laboratories for providing full reference-library service to outlying research laboratories.

The new system incorporates several innovations in the field of facsimile reproduction. The reader-transmitter will scan printed copy or drawings on flat surfaces such as book pages and will make direct enlargements of material in small type by any ratio up to 4 to 1. The copy bed can handle individual sheets or books up to 3 in. thick. The signal is transmitted over an ordinary telephone line and the recorder will reproduce clear, highly legible, black-on-white copy at a speed of 15 linear or 128 sq in. per min.

Operational tests to be started at Oak Ridge immediately will indicate to what extent existing library services at the Laboratory can be expanded without greatly increasing the outlay for new books, particularly scarce and expensive sets of bound scientific periodicals. The system will also prevent possible contamination of books and journals in laboratories using radioactive materials.

A cathode-ray flying-spot scanner at the sending unit is the most important innovation. The 5-in. cathode-ray tube directs a tiny spot of light through a focusing lens to "read" the copy in a thin line from left to right. The reflected light from the copy is picked up by a bank of four photomultiplier tubes which convert the varying light impulses into normal electrical facsimile signals.

The copy bed automatically moves the copy forward under the flying-spot cathode-ray tube. The length of the scanning line on the copy can be adjusted from $2^1/_{16}$ to $8^1/_2$ in. by simply turning a knob. This automatically adjusts the lens to maintain the proper focus, and the same adjustment changes the speed of the copy bed to maintain the correct scale.

The receiver or recorder also incorporates several new mechanical and chemical features to simplify operation and to supply a permanent print of the transmitted material. The electrolytic process used in recording eliminates photo developing and printing and avoids the mess, clogging, and corrosion of previous electrolytic methods. The paper is moistened no more than is absolutely necessary, and as it passes out of the machine it is completely dried. Ultraviolet light fixes the chemicals so that neither the printing nor the background will fade. The clogging and corrosive action of the chemical solution is eliminated by keeping separate the two components of the solution until applied to the paper.

An intercommunication system set up with the system enables the operators of the transmitter and recorder to discuss the material as it comes over the wire.

Heat Pump System

THE heat-pump installation in the central office building of the Ohio Power Company in Canton, Ohio, is notable, according to *Science and Appliance*, October, 1950, because of its size and because it incorporates the previous heating and cooling equipment of the building. Another important item is the coefficient of performance, which is expected to be four or better, that is, four times as much heat as the thermal equivalent of the electric power going in on the wires should be delivered in the building, the bonus being extracted from the earth.

Location in Canton has the advantage of an abundant supply of underground water, always at a temperature in the middle fifties. A 15-hp pump to deliver 350 gpm of water is part of the system. For heating, outdoor air is warmed to 54 F by contact with the well-water coils, and a mixture of this fresh air with recirculated air is heated by contact with condenser coils containing "refrigerant" vapor heated by compression. The compressed vapor gives up its heat of condensation to the circulating air and condenses to a liquid. The liquid is re-evaporated at reduced temperature and pressure in other coils, to which the heat of vaporization is supplied by the well water, and returns to the cycle of heating by compression, condensa-

tion in the heating coils for the building, and vaporization by heat from the ground supply. The discharged well water is colder than before, but controls prevent it from being reduced to freezing and clogging the pipes with slush. The system keeps the building at a comfortable 70 when it's zero outside.

For cooling, the cycle is reversed and the well water becomes warmer before discharge. The condensed refrigerant is vaporized in the air-conditioning coils by heat taken from the air of the building. The vapor is then compressed, after which it is cooled and condensed in the well-water coils and recycled to the air-conditioning coils. Thermostats give automatic control, starting the heating system if the outside temperature falls below 60, and the cooling system when it gets hot outdoors.

The building is five stories tall, with a volume of 468,200 cu ft. A 2-in. layer of cork insulation lines brick walls and flat concrete floor. The previous heating was with steam from a central plant, and cooling was by means of a refrigeration system with a 20-hp compressor, a fan circulating the air in either case. The 20-hp compressor and fan are retained in the new setup, and two 25-hp compressors have been added. (Only one of the new compressors was needed during the mild winter of 1949–1950.) The new year-round system occupies the same basement space as the old. An interesting item in the heat balance used for design of the system on the cooling cycle is an allowance of more than 40 per cent (426,300 Btu) of the 1,019,000 Btu per hr heat gain for heat from the electric lighting of the building.

Highway-Pavement Tests

TRUCKS with heavy axle loads rolling over a mile of Maryland highway, designated Road Test One, Md., are piling up facts and figures pertinent to the long-running debate over the weight vs. highway-life relationship, according to *Civil Engineering*, December, 1950. The test conducted by the Highway Research Board includes four lanes, each about half a mile long. Lanes 1 and 2, which are parallel lanes of a two-lane concrete highway that has been in service about nine years, are tested under 18,000-lb and 22,400-lb single-axle loads, respectively. Lanes 3 and 4, like 1 and 2, are half-mile parallel strips of the same two-lane highway and carry loads of 32,000 and 44,800 lb, respectively, on tandem axles. To October 31, Lane 1 had developed 135 ft of cracks under about 180,000 truck applications; Lane 2, 726 ft under 172,000 applications; and Lane 3, 597 ft under 114,000 truck applications. Lane 4, with 3303 ft of cracks after 92,000 applications, was eliminated from the test on October 13, cracking having progressed so that further traffic was deemed inadvisable. As yet no conclusion can be drawn, and the final report will not appear until after the close of the test.

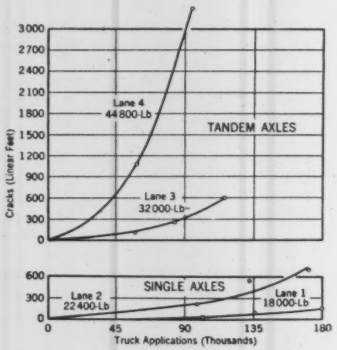

FIG. 8 RATE OF CRACKING IN HIGHWAY-PAVEMENT TESTS

(No direct comparison between curves for single-axle loading and tandem-axle loading, i.e., between Lanes 1 and 2 and 3 and 4, can be drawn at this time since the relation between subsoils is not yet known.)

During the tests careful records are kept of the location and date of each crack as it occurs. Likewise, a rain gage at the site records the amount of rain at the test location, as this figure is highly significant to the results of the test. Bench marks put in by the U. S. Coast and Geodetic Survey serve to keep a continual check on elevations of the pavement. Upon completion of the test, sections of the pavement will be removed and extensive tests made on the concrete itself and the subgrade under the test strip. Electronic counters placed along the strip keep a record of the number of trips made on each pavement. The loaded trucks drive back and forth over their test strips continually for 50 min of every hour, 24 hr a day. Strain-gage measurements are being made along the test strip, and strain gages are measuring the warping stresses caused by the temperature differential between the top and bottom of a slab not in the test section.

During the tests the only maintenance is the regrading of the shoulders and the sealing of the expansion and contraction joints. Cracks due to failure of the pavement are not sealed. When a slab settles to the point of endangering the test vehicles, the point of failure is resurfaced with asphalt, and that particular point is no longer considered in the test.

Stroboscope

MOTION recurring as often as 300,000 times per sec can now be "frozen" either visually or photographically by using a stroboscopic device developed in the Engineering Department's Guided Missiles Division at the Naval Ordnance Laboratory.

Design engineers have indicated that with refinements the device may be used to observe equipment or components rotating or pulsing at even more staggering speeds. They cite as an example the filaments in radio tubes vibrating at extremely high frequency. When such vibration occurs it is accompanied by noise and static in the radio speaker. It is thought that through the use of the new NOL-developed stroboscope it will be possible to discover the cause of these vibrations, leading eventually to their elimination.

Conventional high-speed photography depends upon high-intensity flashing lights synchronized with the camera to "stop" the action of the subject being photographed. This necessitates working in a darkened area which usually requires a slow-down of work going on in the area. The NOL equipment has as its heart an electron tube similar to the snooperscope tube developed to allow riflemen to spot their targets at night. The tube acts as a shutter and allows the camera to be used in normal lighting with no work delay involved.

Operated continuously, the new NOL stroboscope will allow prolonged observation of operating machinery. However, when used as a high-speed camera shutter it will be able to take photographs such as a picture of a missile leaving a gun barrel. This latter development points to the elimination of many of the difficulties presently encountered in photographing projectiles in flight.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Industrial Instruments

The Pitot-Venturi Flow Element, by H. W. Stoll, Taylor Instrument Companies, Rochester, N. Y. 1950 ASME Annual Meeting paper No. **50—A-46** (mimeographed; to be published in Trans. ASME).

THE Pitot-Venturi flow element is a velocity measuring device having found wide use as an air-speed indicator, particularly during World War I. A considerable number of design changes have since been made, and this paper treats a specific form of the element and discusses the effect which the various components used in its assembly have on its calibration. Flow equations are developed and the method of determining the element's coefficient and exponent is described.

The Pitot-Venturi flow element as a fluid-velocity measuring device is subject to all the limitations of this type of primary element. At the same time, because of its ability to develop relatively high differentials when compared with a Pitot tube, it finds useful application when flow measurement must be made under no pressure loss conditions or when pipes are of a size where the customary primary element such as orifice, nozzle, or Venturi are not practical. Its use should be restricted to installations where at no time will the minimum velocity when expressed at 14.7 psia and 60 F be less than 25 fps since the points on the velocity-differential graph become quite scattered at lower velocity values. The maximum velocity at which data have been accumulated to date is 9000 fpm flowing at 15.0 psia and 75 F. These latter data were not assembled under precise control conditions.

Pressure-Temperature Relations in Gas-Filled (Class III) Thermometers, by E. E. Modes, Jun. ASME, J. P. Marsh Corporation, Skokie, Ill. 1950 ASME Annual Meeting paper No. **50—A-48** (mimeographed; to be published in Trans. ASME).

FUNDAMENTAL relations are presented for the pressure within the system of a thermometer or thermal system charged with a perfect gas.

An expression is determined which gives the approximate pressure in terms of bulb temperature, ambient temperature, and ratio of bulb volume to ambient volume; this being sufficiently accurate if the volume change of the pressure-responsive element is small.

An exact equation for the pressure in the system is developed in terms of the temperatures and volumes of bulb, capillary, and pressure-responsive element, and the volume change of the pressure-responsive element, assuming the volume change to be linear with pressure change. From this relation, means are developed for determining the necessary charging pressure to give a specified pressure change when the bulb is varied through a specified temperature span.

In the appendix an example is included in which charging pressure, pressure-temperature curve, and the effect of ambient temperature changes is computed by means of the exact expressions developed.

An Improved Pneumatic Control System, by R. E. Clarridge, Mem. ASME, Taylor Instrument Companies, Rochester, N. Y. 1950 ASME Annual Meeting paper No. **50—A-100** (mimeographed; to be published in Trans. ASME).

A PNEUMATIC control system is being proposed which has one major advantage over conventional systems. This advantage is that the control system can be used to start up a process automatically without overpeaking and at the same time maintain its control point when subsequent load changes occur. The control system is responsive to the rate of change of the control variable during the start-up period and, therefore, good performance can be expected when the performance starts up under varying load conditions.

This has been accomplished by the use of an improved control circuit which has the derivative function in a closed loop ahead of the automatic reset function. A controller of this character has two proportional bands, the first being shifted by the derivative action, and the second by the automatic reset action. Under all stable conditions the first band assumes a given position which

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in a normal controller would be expected to extend on both sides of the control point. The second proportional band is not in a fixed position, but is shifted about the control point by the automatic reset response. It is this shifting which restores the variable to the control point when load changes occur. On start-up this band is always on the opposite side of the control point from the controlled variable so that if it were not for the first proportional band, corrective control action would not be started until the control point was reached and, therefore, overpeaking would be very bad. In the improved control system the use of a wide proportional band, coupled with higher values of the derivative time and reset rate, shifts the automatic-reset proportional band before the control point is reached, and in this manner prevents overpeaking on start-up.

The proposed control system would seem to have great merit on many batch, semicontinuous, and continuous processes. It has the advantage of the proportional plus derivative responses on start-up and the advantage of the proportional plus automatic reset responses on load changes.

Heat Transfer

Heat Transfer in Rocket Motors and the Application of Film and Sweat Cooling, by R. H. Boden, University of Michigan, Aeronautical Research Center, Ypsilanti, Mich. 1950 ASME Annual Meeting paper No. **50—A-53** (mimeographed; to be published in Trans. ASME).

HEAT transfer in rocket motors, as in all internal-combustion engines, is a major factor in determining the limiting performance of the power plant and therefore establishes the limiting performance of the vehicle in which the motor is installed. This paper discusses the distribution of heat transfer in rocket motors, a number of factors which influence it and finally the experimental investigation of film cooling.

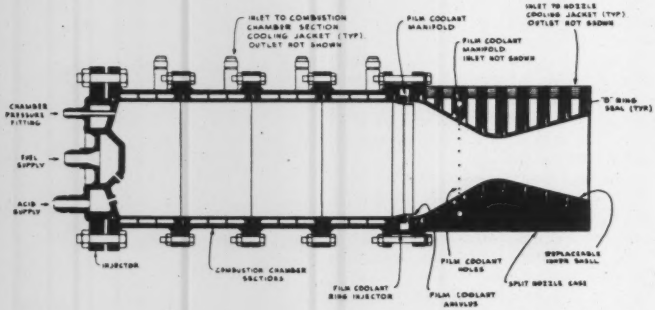
The first step in the research program was to investigate the heat-transfer distribution along the length of a specially designed rocket motor under controlled operating conditions.

Controlled operation was satisfactorily obtained with the application of commercially available automatic regulation equipment and instruments. Operating chamber pressures and propellant-mixture ratios were carefully regulated with this equipment and sufficient data recorded to evaluate heat-transfer rates, and motor operation parameters.

Longitudinal heat-transfer surveys were made and it was found that the critical areas lay definitely in the neighborhood of the throat. The factors contributing to high heat transfer were found to be the combustion-chamber temperature, mass rate of flow per unit cross-sectional area of the combustion chamber, mixture ratio, propellant injector configuration, and the changes induced in combustion by propellant contaminants.

Film and sweat coolant injection methods were investigated. From these it was concluded that the heat transfer in film-cooled sections could be reduced to 30 per cent of the maximum with no film coolant. By properly controlling the operating mixture ratio and the propellant composition in conjunction with film cooling, the reduction to 20 per cent of the maximum heat transfer observed can be achieved. Both cases hold for water used as the coolant.

On the basis of limited experimental data, it is believed that the same figures hold for fuel film cooling.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FILM COOLANT MANIFOLD
INLET TO NOZZLE COOLING JACKET (TYP.) OUTLET NOT SHOWN
FILM COOLANT MANIFOLD INLET NOT SHOWN
"O" RING SEAL (TYP.)
CHAMBER PRESSURE FITTING
FUEL SUPPLY
ACID SUPPLY
INJECTOR
COMBUSTION CHAMBER SECTIONS
FILM COOLANT RING INJECTOR
FILM COOLANT ANNULUS
FILM COOLANT HOLES
DISPLACEABLE THROAT SHELL
SPLIT NOZZLE CASE

ROCKET MOTOR WITH SECTIONAL COOLING JACKET AND FILM COOLANT INJECTORS FOR QUANTITATIVE HEAT-TRANSFER ANALYSIS

A Method for the Calculation of Heat Transfer in Solids With Temperature-Dependent Properties, by Robert Plunkett, Jun. ASME, Rice Institute, Houston Texas. 1950 ASME Annual Meeting paper No. **50—A-54** (in type; to be published in Trans. ASME).

THE problem of heat transfer in a solid, whose conductivity and specific heat depend on the temperature, is converted by a simple change of variable to one in which the conductivity may be held constant, and only the specific-heat term varies with temperature in a way which depends upon the variation of both parameters. The method is illustrated by application to a problem previously solved by Dusinberre in a different way. The effect on the final solution of different finite approximations to the derivatives is also discussed.

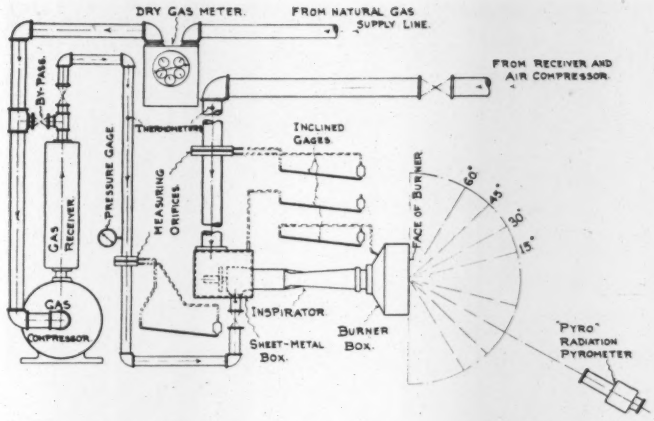
Intermittent Heating for Aircraft Ice Protection With Application to Propellers and Jet Engines, by M. Tribus, Jun. ASME, Cambridge, Mass. 1950 ASME Annual Meeting paper No. **50—A-55** (mimeographed).

THE equations for intermittent heat transfer during icing conditions are presented and solved by means of an electric analog. The results of the analog investigation are compared favorably with measured time-temperature data previously reported in the literature. The analysis shows that contrary to the experience with steadily heated ice-prevention systems, the energy requirements for ice prevention using intermittent heating decrease with increasing ice accretion rate. Corroborative evidence is found in the literature.

The thermal analyzer is used to demonstrate how the protection afforded for propeller deicing may be increased without an increase in the energy required from the airplane's electric supply and without major redesign of existing propeller heaters. In the case of jet-engine guide-vane deicing, for a typical installation, the indicated power requirements are one kilowatt per engine. In each case the minimum energy requirements occur when large amounts of power are applied for short intervals of time. Suggestions for further reductions in power are given.

Radiant Gas Burners, by J. D. Keller, Mem. ASME, Farmers Bank Building, Pittsburgh, Pa. 1950 ASME Annual Meeting paper No. **50—A-59** (mimeographed).

IN view of the revival about nine years ago and the present continuing interest in radiant gas burners, this paper pre-



SKETCH SHOWING ARRANGEMENT OF RADIANT GAS BURNER TEST APPARATUS

sents data obtained during an extensive research project in which many radiant burners of various types were tested.

The object of the research was, first, to test the various types of industrial radiant burners then available on the market, and to determine definitely their capacity, radiating efficiency, required gas or mixture pressure, and operating characteristics; second, to develop, if possible, radiant burners of higher specific capacity having greatly increased radiating efficiency, together with satisfactory length of life; the burners preferably to be capable of operating with an inspirator and inducing the required combustion air from the atmosphere, without requiring a fan or blower.

The commercial burners tested were: (1) The Moran Burner, made by Radiant Combustion, Inc., of Canton, Ohio, a burner of the porous-diaphragm type; (2) The Selas cup-type burner, the best known of all industrial radiant gas burners; (3) The Humphrey "Radiantfire," a type used chiefly for household space-heating but applicable also to certain industrial heating operations.

As to the attempt to produce improved radiant burners, a preliminary survey led to the decision to follow simultaneously two distinct lines, namely, (*a*) Further development of the porous-diaphragm radiant burner, similar to the Bone or the Moran type, and (*b*) development of perforated burner blocks, in which the combustion would occur within numerous open-end cavities in the refractory block, similar to the type described in the literature as used in Germany before the war, and called "steinstrahlbrenner."

Emittances of Oxidized Metals, by John P. Dobbins, North American Aviation, Inc., Los Angeles, Calif. 1950 ASME Annual Meeting paper No. **50—A-58** (mimeographed).

FUNDAMENTAL relationships are derived for computing the thermal emittances of idealized composite surfaces from other known physical properties of the component materials. Metals thinly coated with relatively nonopaque oxides are studied as a special case of the more general configurations considered. To illustrate the method, it is shown in particular how practical engineering estimates of the emittances of bare and oxidized aluminum, titanium, and zinc may be made from known values of electrical resistivities of the metals and refractive indexes of their oxides. The theoretical predictions are consistent with emittance measurements made by the author and with values reported in the literature. Some basic refinements in the definitions of emissivity and absorptivity are separately discussed.

It is concluded that emittances of oxidized metals can be predicted more accurately by means of the quantitative methods developed in this paper than it has been possible to do by only the qualitative outright guessing procedures used in the past. Although the present illustrations were limited to a few simple metals, the methods disclosed can be extended in principle to other metals, including alloys and their oxides. Consequently, in the absence of experimental determinations, engineering estimates of the radiant-heat-transfer behavior of new metals can now be made with the use of smaller safety factors than were formerly needed.

Radiant Interchange Configuration Factors, by D. C. Hamilton, W. L. Sibbitt, Jun. ASME, and G. A. Hawkins, Mem. ASME, Purdue University, Lafayette, Ind. 1950 ASME Annual Meeting paper No. **50—A-104** (mimeographed).

THE continued trend toward higher operating temperatures in heat and power-generating equipment, together with the application of solar and radiant panel heating in building design, have accentuated the need for greater accuracy in the calculation of radiant heat transmission.

This paper, therefore, discusses the fundamental problem of the determination of the effect of geometry on the radiant interchange between two opaque surfaces separated by a nonabsorbing medium. The cases for which solutions are presently available are summarized; this includes new solutions as well as previously reported solutions. Due to the voluminous nature of the results, the solutions are not given but reference is made to a forthcoming publication in which they will be presented in detail. Previous work supplemented by the present extension make solutions available for the majority of cases of simple geometry encountered in engineering, that is, rectangles, cylinders, and spheres. An instrument was designed to provide a method applicable to the complex geometries not solvable by analytical means.

Production Engineering

A Study of Float Requirements for Progressive-Line Continuous Manufacturing, by Maurice Klee, General Motors Corporation, LaGrange, Ill. 1950 ASME Annual Meeting paper No. **50—A-97** (mimeographed).

A STUDY was made to arrive at a logical method of approach to establishing justifiable quantities of material, or floats, allotted to individual departments involved in progressive-line continuous manufacturing in a relatively low-volume industry. Proper float allotments result in the right amount of material, at the right place, at the right time.

As a result of this study, a reduction of both in-process and idle floats has been achieved. This reduction of float necessarily resulted in savings of inventory capital, floor space, warehouse space, material handling, and obsolescence.

No attempt was made to arrive at the intangible savings in terms of dollars, but rather a comparison of float figures is included, to indicate what has been achieved by the Transmission Department toward reduction of floats. The comparison shows the float allotments for major items for 1947 and 1950, with daily schedules included, for traction motors. Similar float reductions were achieved for generators. It should be understood that this reduction of float is a result of this study, of improved methods, and of a concentrated effort to work with minimum floats.

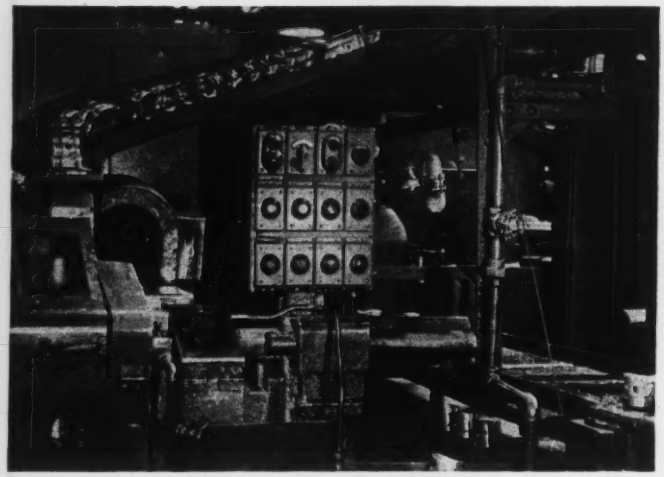
The following recommendations are designed to outline briefly the major thoughts or policies which, when applied, result in maximum operating efficiency with minimum floats. These policies are as follows: (1) Any daily production schedule changes should be smooth transitions, not erratic increases or decreases. (2) All lead times should be kept in harmony with current manufacturing facilities. This necessitates constant review of allotted lead times. (3) Production supervisors should meet the requirements of the daily schedule every day, striving neither to lag behind nor go ahead of the schedule. This is essential when minimum operating floats are in effect. (4) Float allotments should never be reduced to the point where a department's efficiency is affected.

Producing 65,000 Pistons Per Day Using Automation With Quality Control, by W. R. Slattery, Ford Motor Company, Dearborn, Mich. 1950 ASME Annual Meeting paper No. **50—A-117** (mimeographed).

AUTOMATION is the automatic handling of materials being processed between progressive operations. The type of equipment involved utilizes, in most cases, standard elements, such as conveyers, air, hydraulic, and electric control mechanisms to gain the proper movement for elimination of unnecessary manual handling operations.

A wide variety of materials can be handled with substantial savings and at the same time, eliminate hazardous handling such as in large stampings, heat-treat operations, forging operations, and the like.

One of the best tools for controlling quality is the charging of the good and bad performance of machines and processes. A check on what has been done will help improve the work to be done. Charting of this type of information utilizing dimensional data is an added tool of production and is known as Statistical Quality Control. Utilization of this program will aid in quickly tracing troubles to their source.



CLOSE-UP OF AN EXCELLO BORING MACHINE

(The deflecting guide removes the pistons to a turning chute. This chute feeds directly to the loading device on the machine. The wrist-pin boring operation is performed here and it has been found that sample checking of the pinhole for diameter and out-of-round controls quality at this point.)

To illustrate the two programs of Automation and Statistical Quality Control, this paper has been prepared to show an application of automation between machines, which has resulted in greatly reduced handling costs, together with the Quality Control program which operates as part of the system to insure a high-grade product.

Piston production was chosen because of the unique method used and the selective application of Quality Control as required through the various steps in manufacture. This program is based on a complete analysis to be certain that the necessary control of piston dimensions is made with only those control points installed which are necessary.

The automation system resulted in: (1) A substantial reduction in handling labor costs; (2) a better utilization of direct labor by eliminating the need for the operator, in many cases, to load machines; and (3) a reduction of damage to the pistons due to parts striking together, dropping on the floor, etc

Quality Control System benefits were as follows: (1) Improved product quality, (2) reduction of scrap, (3) reduction of rework, (4) serves as a barometer on critical machines to forecast the need for maintenance of machinery and tools, (5) greater job interest and pride among operators, (6) predict some future production troubles, (7) locate troublesome operations quicker, (8) provide recorded facts for higher authority when necessary, (9) prevent additional operations on reject material, and (10) help inspection, production, and engineering departments to study and solve quality problems.

Hydraulic Engineering

The Theoretical Possibilities for Balanced Flow in Compressor and Turbine Design, by Robert W. Pinnes, Jun. ASME, Bureau of Aeronautics, Washington, D. C. 1950 ASME Annual Meeting paper No. **50—A-66** (mimeographed).

IN an effort to obtain peak efficiencies under optimum practical conditions, consideration is being given to the possibility of using balanced flows, other than free-vortex flow, in the design of axial-flow compressors and turbines.

A generalized type of balanced flow—where the whirl velocity varies as some power of the radius—is considered, and the range of operation which is theoretically possible is investigated. It is demonstrated that only free-vortex flow can be maintained under all operating

conditions. Other types of balanced flows such as solid body rotation and constant whirl velocity; can be maintained only under certain limited conditions. A "Balanced Flow Chart" is presented, which immediately shows the range of balanced flows which are theoretically possible in an axial-flow machine for any given set of operating conditions.

The Influence of Reynolds Number on the Performance of Turbomachinery, by Hunt Davis, Jun. ASME, Elliott Company, Jeannette, Pa.; Harry Kottas, Mem. ASME, Lewis Flight Propulsion Laboratory, NACA, Cleveland, Ohio; and Arthur M. G. Moody, Mem. ASME, Elliott Company, Jeannette, Pa. 1950 ASME Annual Meeting paper No. **50—A-99** (mimeographed).

THE effects of Reynolds number on the over-all performance of turbomachinery are relatively unrecognized by the majority of designers and almost totally unknown to the users in industrial and commercial applications. In an increasingly large number of cases, however, Reynolds number effects are of considerable even critical significance.

The over-all duty of a turbomachine with respect to fluid-friction effects is measured by the machine Reynolds number UD/ν. Experimental data are presented for several types of turbomachine which show the variation in over-all efficiency with UD/ν when all other dimensionless parameters are held constant.

In conclusion, the paper states, it is hoped that the data shown present to the operating engineer a clearer realization of the magnitude and scope of Reynolds number effects in all types of turbomachines. The range of Reynolds number tests reported is great enough to show the trend unmistakably but there is considerable risk involved in extrapolating the data to higher values of Reynolds number. There is evidence that the effects of changes in Reynolds number diminish as the value of the Reynolds number becomes large, i.e., in the 10^7 to 10^8 range. There is a lack of quantitative data on large machines which could be used to extend the correlations to the ranges where some large machines operate.

Measured Performance of Pump Impellers, by William C. Osborne, Jun. ASME, and Dr. Dino A. Morelli, Sr., California Institute of Technology, Pasadena, Calif. 1950 ASME Annual Meeting Paper No. **50—A-90** (mimeographed).

THE increasing demand for high-efficiency hydrodynamic machines to meet a broad range of operating conditions had made it desirable to undertake detailed studies of the complete performance of the individual components of such machines. To meet this need a program of basic research on hydrodynamic machines is in progress in the Hydraulic Machinery Laboratory of the California Institute of Technology under the sponsorship of the Office of Naval Research, Fluid Mechanics Branch.

The initial studies conducted in the Hydraulic Machinery Laboratory on a conventional three-dimensional centrifugal-pump impeller, operating free of its case, were reported in November, 1949. Since that time detailed experimental work has been conducted on a series of four impellers, all essentially of the same specific speed but each embodying certain design variations. Qualitative studies have been made of the flow patterns at the inlet, in the passages, and at the discharge of each impeller at flow rates from zero capacity to zero head. Using for the most part the same techniques as described in the original report, the head-capacity characteristics of each impeller have been determined. Input power measurements have been made on two of the impellers, thus making it possible to obtain the impeller efficiencies. The results of these studies are presented and analyzed and correlated with the several design variations. The operating characteristics of two of the free impellers are compared with the performance curves obtained from in-case or complete pump tests using the same impellers. Conclusions are reached as to the significance of the volute in determining the over-all operating characteristics of a centrifugal pump.

A Method of Calculating the Degree of Flow Deviation at the Discharge of Centrifugal-Pump Impellers, by William C. Osborne, Jun. ASME, California Institute of Technology, Pasadena, Calif. 1950 ASME Annual Meeting paper No. **50—A-98** (mimeographed).

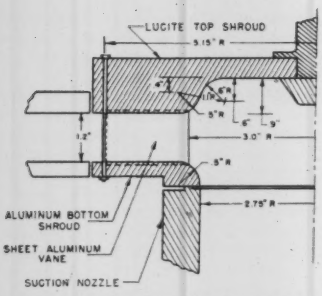
THIS investigation was undertaken to explore the possibilities of a method proposed by Prof. Lewis F. Moody for calculating the degree of the deviation in centrifugal-pump impellers of the mean relative discharge flow angle B_2 from the channel discharge angle B_2'. The analysis, which relates the mean pressure differential acting over a vane face to the degree of deviation, is applicable to three-dimensional impellers and leads to the development of an equation for calculating deviation as a function of the number of vanes, the outlet channel angle, the eye and discharge diameters, and the shroud shapes. The degree of flow deviation in a number of well-designed commercial pumps was calculated from pump test data and the relationship between these values and those given by the theory established.

It is concluded that (1) The method can be used as an aid in estimating flow deviation when designing low to medium specific speed (60 to 200 cfs) radial impellers of the closed or double-shroud construction of conventional design provided. (2) The vanes have overlap. (3) Accurate or at least consistent means of computing the various efficiencies are available. (4) The method shows possibilities in the mixed-flow region. However, due to the increased effect of the eye design on the discharge velocity profile at higher specific speeds, it is believed that a constant coefficient C for all types of mixed-flow designs is improbable. In the development of a series of similar mixed-flow units, once a value of C is established, the analysis may prove to be of advantage. (5) The analysis is unsatisfactory in the high-specific-speed impeller pump range. (6) The analysis can be used as a consistent means of proportioning an impeller for a given set of conditions.

Evaluation of a Two-Dimensional Centrifugal-Pump Impeller, by John H. Beveridge and Dino A. Morelli, California Institute of Technology, Pasadena, Calif. 1950 ASME Annual Meeting paper No. **50—A-147** (mimeographed).

UNDER the continuing sponsorship of the Office of Naval Research, further studies have been made at the Hydraulic Machinery Laboratory of the California Institute of Technology on the flow in rotating channels. The previous work done at the Laboratory, utilized high-efficiency three-dimensional centrifugal-pump impellers representing good modern practice. Their over-all performance in complete pumps had already been measured accurately for other purposes.

The two-dimensional radial-flow pump impeller, which is discussed in this paper, has significant advantages for the study of the transfer and diffusion of energy. It is well adapted to experimental investigation and permits accurate and economical design modifications. The present study was undertaken to evaluate the essential limitations of a special series of two-dimensional impellers by photographic and hydrodynamic techniques which are described in the present paper and elsewhere. The head-capacity characteristics, losses, and efficiency are discussed in the light of visual evidence available from high-



AXIAL CROSS SECTION OF A TYPICAL IMPELLER

speed motion pictures of the relative and absolute flow. The dominant influence of the inlet angle on the impeller performance is demonstrated.

The data and their interpretation show that the two-dimensional impeller is not essentially inefficient. In spite of the narrow inlet which is a consequence of the parallel shrouds, the efficiency is high. A wider inlet will reduce the hydraulic losses and increase the efficiency a little. It will also increase the length of the vanes which are already long by current standards. A wider inlet will have the important effect of increasing the width of the high-efficiency range and broaden the base of the unit characteristic.

An Investigation of Flow Through Screens, by W. D. Baines and E. G. Peterson, Iowa Institute of Hydraulic Research, State University of Iowa, Iowa City, Iowa. 1950 ASME Annual Meeting paper No. **50—A-23** (mimeographed).

THIS report covers investigations of the effects of relatively coarse lattices and perforated plates placed perpendicular to a fluid flow. The effects investigated were dictated by a study of the uses made of screens and were divided into three main categories: the pressure drop across the screen; the modification of the velocity distribution caused by the screen; and the turbulence resulting downstream from the screen. The investigations, all of which were conducted at high screen Reynolds numbers, may be summarized as follows:

1 The pressure drop across the screen was approximated theoretically in terms of the solidity ratio of the screen and compared to the experimental results. Very good agreement was obtained.

2 The modification of the velocity distribution in which the variations are large was investigated by an approximate theoretical treatment and by experiments. Good agreement between the theory and experiments was obtained for screens having solidity ratios less than 0.5, whereas solidity ratios greater than 0.5 were found to yield unstable flow downstream.

3 The establishment and decay of turbulence downstream from screens were investigated experimentally and the decay compared to theoretical expressions derived by other investigators. It was found that the approximate expression of Frenkiel most closely represents the true decay.

4 The variation of the lateral scale of turbulence in the isotropic region downstream from a screen was investigated and the results are presented in dimensionless form.

It is concluded that there is a particular combination of screen characteristics which is most efficient for a particular type of screen application. For example, a single screen made of large bars is more effective in the creation of turbulence, whereas several screens made of small bars are preferable in the dissipation of turbulence. For the elimination of variations in the velocity distribution, a series of uniform screens of low to moderate solidity ratio is indicated. On the other hand, for the production of velocity variations, a single screen of correspondingly varied solidity ratio may be used. If a considerable dissipation of energy (i.e., reduction of pressure) is required, this may be obtained with a single screen of high solidity ratio—but at the expense of evenness in the velocity distribution. A series of screens of moderate solidity ratio is preferred. In all cases the shape of the screen elements is of secondary importance, in that it influences the energy loss but not the general distribution of velocity and turbulence. In no case is a solidity ratio greater than 0.5 to be recommended, owing to the instability which occurs at higher values. By means of the relationships presented in this report, quantitative predictions may be made of the flow modifications to be expected in any such screen application, provided the screen Reynolds number exceeds 100.

Index Testing of Hydraulic Turbines, by Grant H. Voaden, Mem. ASME, S. Morgan Smith Company, York, Pa. 1950 ASME Annual Meeting paper No. **50—A-52** (mimeographed).

AN index test of a hydroelectric unit is a means of determining the efficiency of the unit over its full range of gate opening or output, this efficiency being relative to an assumed or estimated peak efficiency. This relative efficiency may be that of the turbine alone or of the complete unit, whichever is desired.

The object of this paper, therefore, is to bring to the attention of operating companies the benefits derived from index tests of hydraulic turbines, and especially those of the adjustable-blade propeller or Kaplan type; to enumerate and discuss the presently known methods of measuring relative discharge and hence relative efficiency; and to present an example of an index test of an adjustable-blade-propeller turbine in sufficient detail to provide a guide for the conduct of such a test.

It is pointed out that such a test may be conducted in all respects, except for the measurement of discharge, in accordance with the ASME Power Test Code. There is no definite assurance that the best possible efficiency is being obtained from an adjustable-blade propeller turbine unless a field check of the blade-gate relationship is made. An index test is a relatively inexpensive means of determining the optimum blade-gate relationship. It is recommended that all reaction turbines, and especially adjustable-blade-propeller turbines, be tested by the index method where absolute methods are considered inadvisable because of some unusual condition or because of the expense involved.

Gas Turbine Power

High-Speed Aerodynamic Problems of Turbojet Installations, by H. Luskin and H. Klein, Douglas Aircraft Company, Inc., Santa Monica, Calif. 1950 ASME Annual Meeting paper No. **50—A-102** (mimeographed; to be published in Trans. ASME).

THE flight speed trend is examined to show that supersonic airplanes with turbojet engines are to be expected soon. An analysis was made which showed that supersonic wave drags will cause an increase in drag near sonic speed and a thrust increase requirement for the turbo jet.

Performance requirements of a turbojet installation are considered from the point of view of an aerodynamicist whose task is to see that an installed turbojet engine develops as nearly as possible its ideal thrust. It was shown that the difficulty and importance of this task increased with airplane speed. Thus at a Mach number of 2.5, a normal shock inlet loss was 0.60 of the thrust obtainable

with an ideal inlet. The losses in the exit nozzle likewise assumed an increase in importance with higher airplane speeds. Whereas at subsonic speeds the inlet size was not very critical (providing a minimum size was exceeded), at supersonic speeds large drag increments, whose magnitude may be estimated, resulted from an oversize inlet. These scoop drags may be avoided by an adjustable inlet, and an analysis was made of the salient factors governing the matching of the inlet size and the engine. It was shown that the mass-flow ratio, the criterion used for subsonic speeds, lost much of its significance at supersonic speeds.

The ability of a supersonic-turbojet-equipped airplane to stably hold a desired speed with a fixed throttle setting is compared to that of a subsonic propeller-equipped airplane, and it is indicated that careful consideration of the engine controls on a supersonic airplane was necessary to avoid the tendency toward instability created by the parallelism of the thrust and drag curves against speed.

A discussion of jet interference is given, and several photographs of interference phenomena for supersonic jets are shown.

Turbojet Engines for Supersonic Flight, by Arnold H. Redding, Jun. ASME, Westinghouse Electric Corporation, South Philadelphia, Pa. 1950 ASME Annual Meeting paper No. **50—A-141** (mimeographed).

DURING the last decade great strides have been made in aircraft power plants. The rocket engine, the ramjet, and the turbojet engine, all giving very much more power per unit weight than the reciprocating engine, have made supersonic flight practicable. In the speed range between $M = 1$ and $M = 2$ the afterburning turbojet engine appears at present most attractive; primarily because the lighter rocket engine has a much poorer fuel economy while the ramjet, which is intermediate in weight between the rocket and the turbojet engine, lacks in operational flexibility.

It is expected that the afterburning turbojet engine will be a suitable power plant for supersonic flight. The fundamental differences between present-day engines and those capable of powering successful supersonic airplanes are small. However, because of the large thrusts required, a considerable improvement will be needed in the thrust available from a given size and weight engine if any space is to be left to carry sufficient fuel for reasonable range. In order to achieve these engines, considerable improvement in the state of the art may be needed. In addition, these engines will have to be designed primarily for supersonic flight, and at many flight conditions will be inferior to present engines. In this paper the differences between a turbojet engine designed for subsonic flight and one primarily intended for supersonic flight will be examined component by component in order to give a better understanding of the problems of supersonic flight with the turbojet engine.

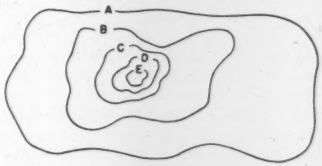
At present it is particularly important to increase the thrust available from an engine of given size and weight so that there will be some room left for fuel. As the ratio of fuel weight to engine weight for supersonic aircraft is increased it will be increasingly important to effect reductions in the specific fuel consumption.

As supersonic flight becomes more advantageous from a tactical standpoint, new engines will be designed to be more nearly optimum for this operation. These new engines will not differ greatly in appearance or function from present afterburning turbojet engines. They will, however, be designed specifically for these applications and incorporate all the latest knowledge in the fast-moving development of aviation gas turbines.

Turbojet-Engine Design for High-Speed Flight, by W. V. Hurley, Jun. ASME, General Electric Company, Lynn, Mass. 1950 ASME Annual Meeting paper No **50—A-130** (mimeographed).

THE design of an engine may be regarded as a series of choices providing increasing amounts of information regarding the final design as the series proceeds. This is illustrated by the accompanying figure.

It is from the set of all possible engine designs, A, that the final choice is to be made. The first step toward this choice is the specification of a mission, i.e., what is required of the engine. This specification will limit the choice to those engines within the subset B. The size of the subset B will depend upon the nature of the "mission" specification.



GAS-TURBINE DESIGN

(A, The set of all possible designs; B, a subset of A determined by specifications of the mission: C, a subset of B determined by specification of the cycle state conditions; D, a subset of C determined by specification of the aerodynamic design; E, a subset of D determined by specification of the mechanical design.)

The next choice to be made is that of the cycle state conditions (pressure ratio, turbine temperature, etc.). This choice has been limited by the statement of the mission and in turn limits the number of possible aerodynamic designs. After the cycle has been established (thus placing the final design within the bounds of subset C) it is possible to state, roughly, the physical dimensions of the engine.

The aerodynamic design is then made, restricting the possible mechanical designs to those contained in the subset D. At this state the physical form and dimensions can be asserted more precisely.

The mechanical design sets forth the physical dimensions in great wealth and detail and narrows the choice of final designs to those lying within the subset E. Of course subsequent testing and modification continue indefinitely and the final design is not obtained until the engine is obsolete.

This discussion centers around the second and third of the choices just outlined—the cycle state conditions and the aerodynamic design. The discussion is limited to turbojets.

Blading for Axial-Flow Compressors, by M. J. Brunner, Jun. ASME, and R. E. McNair, Jun. ASME, Westinghouse Electric Corporation, Lester, Pa. 1950 ASME Annual Meeting paper No. **50—A-113** (mimeographed).

THE basic design properties of axial-flow compressor blade-velocity diagrams are discussed with particular emphasis on stage efficiency and on blade loading. A method of predicting stage efficiency is presented which includes correcting a theoretically obtained basic efficiency for the various secondary losses and for Mach and Reynolds number. Permissible aerodynamic blade loadings are compared for limitations both of blade speed and Mach number.

The paper points out that there is no universal velocity diagram which may be used to best advantage for all compressor applications. Each type has a limited range of application to which it it is best suited. From this discussion of the various blade-velocity diagrams emerges a definite pattern of where to apply each type. High-pressure-level regenerative power plants with intercoolers will require low speed for both the reduction of diffusion losses and for

low stresses commensurate with long life, and these will require compressor blading of the high per cent reaction types. At the other extreme will be the transportation power plant. With limitations of space and weight and with increased pressure ratio they will run at higher speeds and will favor the symmetric velocity diagram. There will also be intermediate conditions that will require compromised blading diagrams. As optimum efficiency conditions become more accurately determined, compressor designers will employ more complex velocity diagrams which vary both with radius and with axial position in the machine. With the refinements, higher efficiency levels and greater work per stage will be realized in future designs.

The data required for the ideal design of axial-flow compressor blading is still far from complete. Both government agencies and private industries are continually searching by theory and experiment for more complete data. Some of the most important problems are the effects of blade loading on stage efficiency for various blade orientations, the variation of drag over lift coefficient with blade orientation in a rotating cascade, the accurate and complete evaluation of Mach number effects on efficiency and stage output, and the detail analysis of three-dimensional stage effects.

A General Theory of Three-Dimensional Flow With Subsonic and Supersonic Velocity in Turbomachines Having Arbitrary Hub and Casing Shapes—Parts I and II, by Chung-Hua Wu, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1950 ASME Annual Meeting paper No. **50—A-79** (mimeographed).

THIS paper, which is in two parts develops a general theory of steady three-dimensional subsonic or supersonic flow in turbomachines. The theory is applicable to both irrotational and rotational flow and at design or off-design conditions. The solution of the problem is made simpler by solving a combination of flows on relative stream surfaces which are formed by fluid particles lying on circular arcs and radial or inclined lines upstream of a blade row. The flow on such surface is mainly described by a nonlinear second-order partial-differential equation, the characteristic of which depends on the relative magnitude of the local velocity of sound and a certain combination of velocity components. A general method of solving this equation when it is either elliptic or hyperbolic, by hand or automatic-machine computation, is described. The results obtained in applying the theory to a number of typical compressors and turbines indicate that the theory is sound and the method is practical.

In the study of compressible flow in a single-stage axial turbine, it is found that: (1) Radial flow exists even in the free-vortex design due to the compressibility of gas, the thickness of the blade, and the radial twist of the blade; (2) for thin blades, the compressibility of gas and the radial twist of the blade have an equally important effect on the three-dimensional flow; (3) if the blade is very thick, its effect may predominate over the others; (4) the position where the radial element of the stator is chosen offers a practical means of controlling the distribution of radial twist of the stator and its effect on the gas flow, and (5) the simplified-radial-equilibrium calculation gives a lower Mach number and a higher angle of attack at the tip of the rotor, and a higher Mach number and a lower angle of attack at the root of the rotor.

In the case of a single-stage and a seven-stage axial compressor based on the design of "symmetrical velocity diagram" at all radii, it is found that: (1) The variation of circulation along the blade span has a much more important effect on the three-dimensional flow than the effects of compressibility and radial twist of blade; (2) the effect of radial twist of the blade is negligible due to the relatively small radial twist involved in this design and the small deflection of the compressor blading; (3) the solution based on incompressible flow gives good approximate results in the streamlines, and the shape of axial velocity profile in the radial direction, but not in the magnitude; (4) the simplified radial-equilibrium approximation gives a smaller radial gradient in the axial velocity profile in front of the rotor and a much larger radial gradient in the axial velocity profile behind the rotor, which results in an error in the air angles up to three degrees at these two stations and in an error of much flatter radial variation of Mach number; (5) the approximate solution based on a simple sinusoidal curve gives very good results and should be good enough for ordinary engineering computations; and (6) in the case of multistage compressor, the meridional streamlines can be taken as consisting of a simple sinusoidal curve on a mean line which is controlled by the shape of the inner and outer walls, and the effect of the oscillatory radial flow is largest in the first two stages.

The results obtained in the case of mixed-flow impeller indicates that the method developed is particularly useful in analyzing the three-dimensional flow in such machines. Comparison of the theoretical three-dimensional flow obtained in this manner and detailed measurements obtained in experiment should help to ascertain the exact extent of the viscous effect and to incorporate its effect in future designs.

In the inverse problem, it is clear from the analysis that in addition to the blade-thickness factor, only one relation among the fluid properties can be prescribed by the designer on the mean stream surface. The method should be very useful in designs where a certain thickness distribution is desired from strength or coolant-passage consideration. The method is particularly useful in designing blades for compressible flow in turbomachines, which have large variation in either hub or casing radius.

ASME Transactions for January, 1951

THE January, 1951, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Investigations of Axial-Flow Compressors, by J. T. Bowen, R. H. Sabersky, and W. D. Rannie. (49—A-102)

Experience With Machinability Repeat-Ability, by E. J. R. Hudec. (50—S-2)

A Study of Heat Developed in Cylindrical Grinding, by R. E. McKee, R. S. Moore, and O. W. Boston. (50—S-11)

Machining of Heated Metals, by E. T. Armstrong, A. S. Cosler, Jr., and E. F. Katz. (50—S-5)

The Effect of the Cutting Fluid Upon Chip-Tool Interface Temperature, by M. C. Shaw, J. D. Pigott, and L. P. Richardson. (50—SA-19)

An Analytical Evaluation of Metal-Cutting Temperatures, by K. J. Trigger and B. T. Chao. (50—SA-1)

Residual Stresses in Machined Surfaces, by E. K. Henriksen. (50—SA-27)

Properties of Thin-Walled Curved Tubes of Short-Bend Radius, by T. E. Pardue and Irwin Vigness. (50—S-21)

Safety Margins and Stress Levels in High-Temperature Equipment, by Ernest L. Robinson. (50—SA-28)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Oil-Shale Mining

COMMENT BY PHILIP B. BUCKY[1]

The authors have presented a paper[2] of particular interest to the mining and mechanical-engineering professions, for they combine both to increase the productivity per man-day and the safety of underground workings. When one realizes that the average production rate per man-day in the American mines is 6 tons and that the production rate at Rifle, Colo., is well over 100, an appreciation may be had of the accomplishments to date, and of the future possibilities.

It is felt that the title of the paper might better have been "Modern Developments in Mining," instead of "Oil Shale Mining," for the concepts here presented are applicable to the mining of any and all minerals.

Mining being one of our oldest arts, the inertia to change is considerable. In the past men have learned the art from practical experience, and the reliance in some mines is still on the experience and judgment of the miner. Many of our state mining laws still rely on the judgment and experience of the mine inspector to determine when certain acts shall or shall not take place. The procedure presented by the authors is probably the first, where scientific laboratory tests, and special engineering planning and research took place before the work was started. While it is not specifically mentioned in the paper, it is believed that this concept, due mainly to E. D. Gardner, is one of the most important contributions to the mining industry.

A procedure is also presented for developing a full-scale unit with all its complements for the working of an ore body.

While the accomplishments of the unit used are relatively excellent, it is felt that present results are only indicative. For example, what would the production rate per man-day be if:

(*a*) Rooms were 100 instead of 60 ft wide?

(*b*) Shovels were 5 yd or more instead of 3?

(*c*) Each haulage unit had one or more trailer units attached to it?

(*d*) A method of drilling and blasting using holes 100 ft or more in length were used?

The raising of these questions which are a small portion of those available indicate the possibilities of production accomplishments which by comparison will pale those at present available.

As one reads the paper the impact of science and engineering on the economics of production come more and more to the fore. Many of us would be interested in the logic and facts which lead to the conclusions: "..... 22-ton trucks would be in better accord with the size of the shovel." "A portable air compressor has advantages over stationary ones." "A square mile appears to be a good mining unit."

The writer realizes the impossibility of including such presentations within the bounds of this paper.

The solutions which the authors indicate as having been accomplished are, however, of considerable interest to the profession, and it is hoped will be made available in printed form.

A mining person cannot help but be impressed by the relatively high powder costs when compared to the rest of the operating costs. These costs are about equal to those obtained in regular practice. However, they indicate the importance of blasting and fragmentation studies in the further reduction of mining costs.

To the men who have conceived and carried on this work, and to the U. S. Bureau of Mines, the country and industry may well express appreciation for work well done.

[1] Professor of Mining, School of Mines, Columbia University, New York, N. Y.; Consulting Engineer.

[2] "Oil-Shale Mining," by E. D. Gardner and E. M. Sipprelle, MECHANICAL ENGINEERING, vol. 72, September, 1950, pp. 701–706.

Motors for Integral Mechanisms

COMMENT BY L. S. LINDEROTH, JR.[3]

The following comments and questions are from the point of view of a machine designer and mechanical engineer.

Within the limitations defined by the author, the paper[4] gives a very clear and complete description of some of the electrical components available for use in this type of mechanism.

One wonders why integral mechanisms of this type should be limited to single-phase 60-cycle motors. The writer's experience includes many cases of polyphase motors used in this way. It also includes the use of high-frequency integral motors, particularly in high-speed quills for routers and internal grinders. Again, why not include face and flange-mounted motors? Particularly in the machine-tool field, this type of motor has been used extensively and becomes just as much an integral part of the mechanism as the motor illustrated on the garbage-disposal unit.

The writer is curious as to why the integral-mechanism motor should be "safer." The author mentions this at several different points in the paper but does not explain the term. There seems little reason to justify the statement that integral designs are better-lubricated. It is of course obvious that, if a design is to be hermetically sealed, the lubrication must be considered carefully, but there is no reason why this same care could not be taken in standard motors. With the trend toward life-lubricated ball bearings in motors, lubrication is no longer a major problem.

The major disadvantage of the integral-mechanism motor is that it does not lend itself to easy change to meet the many different types of electric service in the various parts of our country. It is true that a great effort has been made to standardize the single-phase a-c power lines at 110 v and 60 cycles in the homes, but industrial power in polyphase circuits and d-c circuits is found in all combinations of voltages and frequencies.

[3] Professor, Department of Mechanical Engineering, Iowa State College, Ames, Iowa. Mem. ASME.

[4] "Motors for Integral Mechanisms," by T. T. Woodson, MECHANICAL ENGINEERING, vol. 72, August, 1950, pp. 615–628.

The designer of industrial equipment is, therefore, under a considerable handicap in comparison to the appliance designer when considering the advisability of using integral motor mechanisms.

AUTHOR'S CLOSURE

Professor Linderoth is correct in pointing out that machine designers, many times, face polyphase motors as well as high-frequency motors. Parenthetically, face and flange-mounted motors were referred to in the paragraph of NEMA induction-motor frame sizes, page 624 of the August, 1950, issue of MECHANICAL ENGINEERING. In this paper, the author's primary intent has been to discuss the motor supply parts against the motor mounting parts. A second paper is now in process which will discuss the mechanical considerations of integral motor design, these perhaps being the ones most needed by the machine designer. In terms of numbers used, however, the single-phase motor still has the interest of a wider group of engineers and designers needing this particular information.

The author refers to the motor safety, both mechanically and electrically, simply for the reason of the enclosure. This was particularly emphasized in the paragraph concerning hermetic mechanisms where by definition the enclosure is solid and protects the motor from external damage and the operator from personal hazard. Most hermetic motors are pressure-lubricated and, of course, contain a lifetime charge of lubricant which it is impossible to lose, in contrast to typical open bearings, whether smooth or ball. The retention of the lubricant determines the life, and leakage thus has to be very carefully avoided.

On the subject of electric service, the Edison Electric Institute reports that of the forty-million meters installed on utility systems, less than twenty-five thousand are for twenty-five cycles. Less than one per cent of the installations are 50-cycle circuits. In many applications, a 50-cycle output speed is tolerable compared to the 60-cycle speed. In the balance of the cases, a 60-cycle design must be changed to be used on the 25, 40, 50 or $62\frac{1}{2}$-cycle circuits remaining. There are appreciable d-c circuits, but they are primarily hotels, hospitals, and institutions requiring a stand-by service. It is felt that the net result is still the tremendous predominance of the 60-cycle power supply.

T. T. WOODSON.[5]

[5] Engineer, Advance Engineering, General Electric Company, Bridgeport, Conn. Mem. ASME.

Machines and Forestry

COMMENT BY H. E. HOLMAN[6]

This paper[7] points out a number of fields where more efficiency and lower cost would be possible through the application of properly designed machines to do a larger percentage of the work. The author has covered a large number of important activities in the entire field of forestry and has put special emphasis on the need for renewing and conserving our timber stands through more extensive planting and seeding, and protection from fire and insects. A considerable amount of emphasis and study in past years has been devoted to the need for better fire protection, better insect control, and better harvesting techniques, which include the application of good forest-management principles. Considerable benefit has resulted, but there is still a long way to go before we have the major part of our forest areas under good sound practical management programs. The job from here on is complicated by the fact that 261.4 million acres of forest land is owned by 4.2 million owners. This means that 75.8 per cent of our forest land is in ownership of less than an average per owner of 62.2 acres.

The forest-products industries are not only one of the basic industry groups in the United States, but also one of the largest industry groups in the country. These industries are dependent upon a raw material that is renewable, which has been pointed out by the author. The rate of regeneration can be accelerated by applying proper cultural practices. The cost of intensive cultural practices has been a limiting factor in many instances. The development of machines that will perform a larger portion of the work will reduce cost and bring more forest land under management. We should look upon the entire forest area of 461 million acres as a possible market for more efficient equipment.

Even through a considerable portion of our forest area is mechanized, there is still room for a lot of improvement, and in those areas where mechanization is woefully lacking, there is an almost unlimited potential market for all types of machines. In the writer's opinion, this is one of the most fertile fields and presents one of the most challenging problems to engineers of all types. The forest-products industries already have stimulated the development of specialized machines for the purpose of overcoming production and distribution problems and, as the present more available stands are cut, it will require the application of even more efficient harvesting methods in order to maintain economical operations. The more efficient harvesting methods are largely dependent upon more and better machines.

There is another phase of forest conservation that the writer believes fits admirably into the whole subject of forest utilization and forest conservation. In many parts of our timbered area very little thought has been given to the potential value of sawmill waste and logging debris. It is true that a considerable amount of work has been done to determine the probable available sawmill waste and logging debris that are developed as a result of producing a given amount of finished product, and also a considerable amount of work has been done to develop products that can be manufactured from the waste materials. We find ourselves in a position where we have a tremendous amount of potential raw material and a considerable amount of information pertaining to the potential end products, but we do not know enough about the factors which determine the practicability of using this abundant supply of raw material. We have too little information pertaining to the cost of reclaiming this waste and converting it to a marketable product. Here in the writer's opinion is one of the most fertile fields of endeavor for the engineers. It will not only challenge the ingenuity of the mechanical engineers, but it presents an equal challenge to the chemical, civil, electrical, and other engineers especially trained in the problems of transportation.

According to the forest Reappraisal Report No. 4, there was almost 3 billion cubic feet of logging debris not used for any purpose in the year 1944, for which we have the last figures. This converts into about 23 million cords of wood. It is conceded that a considerable amount of this volume was probably unusable because of its size and quality and, unquestionably, a large volume was unusable by virtue of the fact that it was not located within economic distance of a converting plant. We need to know what economic factors control, and how the economic limits can be extended.

The development of better reclamation techniques unquestionably would make it possible to use tremendous volumes of

[6] Chief, Forest Products Division, Office of Domestic Commerce, U. S. Department of Commerce, Washington, D. C.

[7] "Machines and Forestry," by A. P. Dean, published in MECHANICAL ENGINEERING, for September, 1950, pp. 727–729 and 732.

this type of raw material in the manufacture of many of our products which now depend on the cutting of standing timber. The writer distinctly remembers a number of years back, when he first went to the Pacific Northwest there was practically no effort made to reclaim either the logging debris or the sawmill waste. The price of timber was such that it was not economically possible to handle timber of very low quality. However, the economic situation has entirely changed. We now find that a large number of operators in the Pacific Northwest, Lake States, in parts of the South, New England, and other areas are finding it economically advantageous to utilize large volumes of what used to be completely waste material. This was made possible because of improved machines.

About a year ago the president of one of the large pulp mills on the Pacific Coast told the writer that when they built the plant they purchased enough timberland to support the plant at full capacity for a period of 50 years. The development of new machines has made it possible for this mill to use a considerable quantity of logging debris and sawmill waste in their pulping processes and, as a result, the company has been able to extend its life period to 75 years without buying another acre of timberland. The development of better transportation machinery, machines that can be used in the various phases of collection, and better machines for converting the waste material to a finished product are needed by every timberland owner and every producer of forest products.

COMMENT BY L. C. KIBBEE[8]

We should not try to have fire apparatus which is self-contained and used exclusively for fire fighting, as it is too expensive for the work it has to do. Being human, we hate to spend money when we are not sure it will be used.

In the forest fires that swept the countryside in Maine a few years ago, lumber companies, local and national agencies, were crying for fire-fighting equipment with which to combat the flames. Oil trucks were converted to water wagons. All pumpers worked until they broke down, and all to little avail. The trouble was that there were just not enough pieces of equipment that could be converted on the spot, and there were not enough people who knew how to fight a forest fire.

What the writer would suggest is a fire pump which can be mounted on the front of any logging truck, so all that is standing by when there is no fire is just the pump and not a whole fire unit, complete with engine, or even a whole fire truck. This also allows the pump to be removed from one logging truck and coupled to another in a few minutes if the first truck breaks down, while pumping. Fire-fighting equipment should be an auxiliary unit operated in conjunction with revenue vehicles, and not something resurrected from the dead when trouble develops. In addition having many of this type of simple units available makes it possible for personnel to become familiar with it, so they can use it when the need arises.

There is a crying need for the training of the logging personnel in fire-fighting techniques. This will mean as much as equipment when the woods are ablaze. For example, in the Maine conflagration, when the oil trucks were made available to the fire fighters, for hauling water the writer saw many of them with the truck alongside the streams contemplating how they would get the water out of the river and into the tanks, merely because no provisions had ever been thought out before the emergency arose.

While on the subject of fire apparatus, it may be said that the fire pump also could be designed to work a spray rig used to combat insects and organic tree damage.

With the advances in cross-country vehicles recently being tested by the Army, where the tracks have been replaced with multiple axles with low-pressure tires, there might be advantages in this type of vehicle which could go almost anywhere, a tractor can now be loaded to capacity, and drive directly to the mills. This would eliminate the costly yarding of logs with track-type tractors, and then reloading onto conventional trucks for the trip to the mills. Frankly, there would seem to be no reason why the logging trucks must be a counterpart of the highway vehicle when it would do a better job if designed strictly for the work it has to do.

We in the highway transportation industry started off to build a transportation network 30 years ago working with mechanized equipment designed around horse-cart ideas. We didn't like what we had, and we were quick to tell the manufacturers about it, and, in the course of events, we soon had vehicles available to us much more to our liking. The fight is not over yet, and the truck manufacturers will be quick to tell you that association-wise we keep them acquainted with the shortcomings of their units. Do not misunderstand me, this criticism is almost invariably welcomed by the manufacturers, and they strive to give us what we want. The result has been most gratifying, as evidenced by the advances made in highway vehicles in recent years.

Paralleling this program, it is suggested that a logging-industry equipment committee be formed, which could draft the requirements into specific requests and present them to equipment manufacturers. This is the course we at ATA have followed. A point to keep in mind when this type of meeting is afoot is to work in some standardization at the same time, for, no doubt, the lack of standardization is the plague of the logging industry as it is of ours.

In the writer's lifetime, horses were the principal means of logging power in the New Hampshire woods, when the West was using Diesel engines. Southern pulpwood was coming out on corduroy roads in $1^1/_2$-ton trucks when the West was rolling out 100,000-lb loads on their own roads at 30 mph. Again, forgive the comparison of logging with highway trucking, but it should be pointed out that many of our so-called "new" ideas regarding trucks here in the East have been practiced for years in the West; Diesel engines, multiple axles, truck full-trailer trains, and lightweight construction, to mention only a few items, which have drifted East from the Coast.

So, in logging here in the East, do not hesitate to realize the economy of big units, Diesel power, mechanized loading, and the like. It has paid off elsewhere, and it is undoubtedly coming here to a fuller extent than is presently practiced.

AUTHOR'S CLOSURE

Mr. Holman's comments are most appropriate. They call attention to an aspect of mechanized forestry which, although omitted from specific mention by the author, is acknowledged to be of utmost importance in making forestry pay.

Reclaiming the waste that occurs at the stump, during logging operations and at the sawmill is, indeed, essential if we are to obtain the maximum yield from our forests in terms of both national wealth and owner profits.

As suggested by the author, converting the waste resulting from present-day harvesting and milling practice into useful wood products is a challenge to many branches of the engineering profession. Meanwhile, any development which will increase the return from the forest or the woodlot will create greater

[8] Equipment and Operation Section, American Trucking Associations, Inc., Washington, D. C.

incentives for better management of our timber stands.

Mr. Kibbee makes a timely point in reminding us to keep after the development of forest-fire control and log-transportation equipment. He offers some good leads for improving these types of forestry machines.

We shall also be wise to heed his implied advice to avoid being bound by familiar or conventional types of equipment and his suggestions for keeping ourselves acquainted with developments throughout the country.

A. P. DEAN.[9]

[9] Chief, Division of Engineering, Forest Service, U. S. Department of Agriculture, Washington, D. C.

Students in Community Affairs

TO THE EDITOR:

You will be interested to know that the undergraduate student has a real interest in assuming civic responsibility, not after he has finished his college education but as a part of the training in community service along with his college work.

On Nov. 24, 1950, at the National Interfraternity Conference, I had the privilege of leading a discussion on the subject of fraternity participation in community affairs. I expected a handful of undergraduates in attendance, lukewarm to the subject. I am pleased to say that about sixty men attended; they stayed for two hours, and almost every man made some contribution to the discussion. We ran overtime and it was difficult to end the meeting.

The underlying philosophy of such participation was based on the idea that college education is not just a preparation for life, it *is* life, and the student should be a part of the local community when he is away from home, since he cannot carry civic responsibility at home. Frank recognition was made of the fact that in our society much useful work is done by volunteer workers in the community, and the student who gets into such work is learning to serve society and continuing his training in a sort of apprenticeship capacity for more valuable service later. While some students looked upon such activities as a means of creating good public relations, the majority were concerned for the work itself and regarded the public-relations aspect as a by-product.

The type of work which students are doing in college communities is extremely varied. Among the important activities mentioned, the following appeared to be indicative of the whole scope of community participation:

Some students are doing volunteer work in hospitals, especially where an epidemic prevails; others are working with the local Red Cross; and others are taking the responsibility for the maintenance of a blood bank in the local hospitals.

On some college campuses, fraternities, or groups of students have a program for delinquent children who have been before the courts, and students are trying to re-orient the activities of these children. Another form of activity is in the local churches, where they are carrying responsibilities for both the spiritual and humanitarian work of the local congregations.

Some fraternities are making "junior pledges" of neighborhood boys and providing a program of activities for them throughout the year. Another type of activity consists in the support of cultural projects, such as art exhibits and symphonic music.

Students with an interest in political life have engaged in nonpolitical activity getting voters to register.

This is far from a complete listing, but it will serve to illustrate the many means which students use to increase their proficiency in civic life. It was a refreshing experience and it indicates that the American college student is interested in more than studies, sports, and a good time.

FRANK R. HUNT.[10]

[10] Dean of Students, Lafayette College, Easton, Pa.

Standards for Lantern Slides

TO THE EDITOR:

Your editorials entitled "Lantern Slides" and "The End Crowns All," MECHANICAL ENGINEERING, vol. 72, June, 1950, p. 454, are of interest to the present American Standards Association Sectional Committee Z15 inasmuch as one of its subcommittees is entitled Z15.1, "Engineering and Scientific Charts for Lantern Slides," and another is entitled Z15.3, "Engineering and Scientific Graphs for Publications." Both these Standards are currently under revision, due to the concurrence of the Sectional Committee with the views so well expressed in your articles. A letter to the editor entitled "Lantern Slides," in your September issue, p. 752, shows, however, that a misinterpretation of the first two articles is easily made, obscuring the fact that the independent Standard does exist for "Lantern Slides." The eminence of the personnel of these subcommittees gives promise of fine revisions and should help bring forth this much desired improvement in lantern slides and graphs for publication.

DOUGLAS P. ADAMS[11]

[11] Chairman, ASA Sectional Committee, Z15.

Ernest John Sweetland

TO THE EDITOR:

Ernest John Sweetland, who was born in Carson City, Nev., May 26, 1880, died in San Francisco, Calif., Nov. 15, 1950.

Instinctively, he had an extraordinary faculty for the creation of things mechanical and was endowed with the mind of inventive genius.

His first achievement, which brought him outstanding success, was the Sweetland filter press which he patented Nov. 7, 1916. The Sweetland filter revolutionized the filtration process in the sugar-refining industry and since its universal acceptance throughout the world no substitute or modified filter has taken its place in this all-important industrial process.

His world-renowned invention of the Purolator for filtering the oil in automobiles has been universally adopted and used since 1925 in the automotive industry.

In 1933 Mr. Sweetland sustained critical injuries in an automobile accident while on a trip to the High Sierras to inspect a camp site for the Boy Scouts Organization of Piedmont, Calif., where he had resided since 1928. While in the plaster cast which enveloped his body and legs, he invented and patented a hot-air drier to quickly dry plaster casts on persons. Also, at that time he invented and patented a hot-air method of treating patients in "shock" by heating the entire body placed in a tent over the bed. Other inventions for hospital use, including a very recent one of a hospital bed, cover a long list of such inventions to relieve suffering humanity.

After patenting the filter press, Mr. Sweetland founded the United Filter Company, New York and Hazleton, Pa., to produce and market his invention. Its novel features and usefulness in and by the sugar and other industries brought him world fame as an inventor, success financially, and high engineering and scientific recognition.

The Franklin Institute of the State of Pennsylvania (Philadelphia) awarded him in 1918 the John Scott Legacy Medal and Premium "For the Promotion of the Mechanic Arts," particularly for the development of the Sweetland filter press.

Also he was awarded a certificate by the National Association of Manufacturers "In recognition of distinguished achievement in the field of science and invention" in February, 1940.

Mr. Sweetland's instinctive sense of things mechanical and his inherent mechanical ingenuity places him high in the long list of successful inventors of the United States and the world. He successfully patented some forty mechanical devices. He most fittingly held the classification of "Inventor" in the Rotary Club of San Francisco since 1929, and previously was a member of the Rotary Club of Hazleton, Pa. He continued his interest in his inventions and the development of his ideas, up to the very last.

In his passing the world has lost a great inventor, engineer, and scientist. Those who had the privilege of knowing him highly prized the warmth of his friendship and they will ever cherish his memory.

Mr. Sweetland became a member of The American Society of Mechanical Engineers in 1917.

Mr. Sweetland is survived by his widow, Mrs. Nellie R. Sweetland, three daughters, three sons, and thirteen grandchildren. A forth son ("Ted") lost his life in World War II. Two surviving sons, Ernest J., Jr., and Eugene D. belong to the ASME.

WARREN H. MCBRYDE.[12]

[12] Past-president, ASME, San Francisco, Calif.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

The Properties of Metallic Materials at Low Temperatures

THE PROPERTIES OF METALLIC MATERIALS AT LOW TEMPERATURES. Vol. 1. By P. Litherland Teed. John Wiley and Sons, Inc., New York, N. Y., and Butler and Tanner, Ltd., Frome and London, England, 1950. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., tables, figs., index, viii and 222 pp., $3.50.

REVIEWED BY IRVING ROBERTS[1]

IN RECENT years, the problem of choosing materials of construction for low-temperature service has become one of major importance, primarily because of the development of large-scale process plants which operate at temperatures as low as minus 340 F. These plants involve both stationary and moving types of low-temperature equipment, each presenting an individual materials problem, and requiring, for the available metals, a knowledge of their important mechanical properties such as impact strength, limiting fatigue stress, yield stress, ductility, and stability under temperature and stress variations.

This book, the first in the field, is a collection and a critical appraisal of the available data up to 1948 on the more important metals. Chapters 1 and 2 give a thought-provoking introduction to the subject. Chapter 3 is devoted to aluminum and its alloys. Chapter 4 covers all properties of ferrous alloys with the exception of impact, and chapters 5 and 6 cover the impact properties of carbon steel and alloy steels, respectively, including the properties of welded joints. Chapter 7 deals with magnesium alloys, and chapter 8 with copper and copper alloys. Chapter 9 is devoted to the properties of nickel, zinc, tin, lead, and their alloys. Chapter 10, a short concluding chapter, is followed by a detailed subject index, and by an index of alloys with numerical designation.

The author has done an excellent job of organizing the data and presenting them clearly in tabular form. Any property of a particular metal or alloy can be found with ease, and a reference to the original source is given with each item. The task of evaluating the data is a difficult one, not only because of the scarcity of results, but also because of the conflicting results in many cases. The author discusses the data with caution, and his conclusions are well considered and conservative. The numerous inadequacies in the data are pointed out, showing the need for further research in this field. The style is informal, and makes for easy reading.

This reviewer found the chapters on the impact properties of carbon steel and of the ferrous alloys particularly enlightening. These chapters should be required reading for those who insist on any arbitrary value of impact energy as an acceptance test of a metal. Much remains to be done to determine the significance of impact tests at low temperatures. The reviewer was disappointed to find no mention of the properties of cast iron, a widely used engineering material, even at low temperatures.

It is unfortunate that, while the book was written in 1948, it was not published until 1950. During the past two years many papers have appeared which, although not in conflict with the generalizations of the author, add considerably to our fund of information on this subject. In addition, some inconvenience may be felt by American readers as a result of the fact that the book was written according to English conventions. Stresses are expressed in long tons (2240 lb) per square inch, temperatures in degrees Centigrade, and in most cases, the American designations of ferrous alloys (SAE or AISI numbers) are absent. However, these disadvantages are minor when compared with the value of having the information in this field logically collected in one reference work. This book is highly recommended to designers of low-temperature equipment and to metallurgists alike.

[1] Consulting Engineer, Elliott Company, Jeannette, Pa. Mem. ASME.

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Treatise on Powder Metallurgy

TREATISE ON POWDER METALLURGY. Vol. 2, Applied and Physical Powder Metallurgy. By Claus G. Goetzel. Interscience Publishers, Ltd., London, England, 1950. Cloth, $5^3/_4 \times 9$ in., tables 83–285, figs. 301–628, author and subject indexes, xviii and 910 pp., $18.

REVIEWED BY A. J. LANGHAMMER[2]

THIS book by Dr. Claus G. Goetzel is an outstanding literary composition on the subject. It will make an excellent textbook, and serve similarly for the purpose of review by engineers, and for their guidance in fields other than the particular one in which they may be engaged.

The subject is covered in a broad, yes, very broad, manner. Thus the metals and alloys treated range from refractory metals to hard metals, electrical materials, magnetic materials, ferrous materials, nonferrous materials, porous products, friction products, and a number of miscellaneous products. In each case the author treats the individual subject in detail through raw materials and their fabrication, also the production of the unit or part, and the end use. Raw materials, that is, the manufacture of the powder and subsequent treatment is outlined. Similarly, the sequence of operation for manufacturing a part of powder metal is described along with comments regarding the types and characteristics of the machinery and equipment involved.

There is a fine mixture of practical and theoretical considerations. Moreover, the work of research by competent authorities is treated in considerable detail, accompanied by charts, photographs, and the author's comments, with full credit to the responsible parties.

The theoretical aspect of sintering is well covered, and the theories of prominent investigators listed and discussed. Dr. Goetzel points out that in spite of existing theoretical data, powder metallurgy was fairly dormant until the twenties. This is correct, but it is the writer's observation that progress intitiated at that time was not based primarily upon theories, but rather upon practical work and experiments conducted along the lines of Hatfield and F. W. Taylor. This, in the writer's opinion, is important because it points the way to the solution of problems on the part of students and engineers when their particular problem cannot be solved by reference to textbooks or pertinent literature.

Dr. Goetzel, in this book, treats the fundamentals and generalities very well indeed, and devotes time and space in the interest of clarification and proper emphasis.

Under the author's paragraph "Qualitative Evaluation" might have been included variation in results achieved when powders of different manufacturers and/or different processes are involved. This is quite appreciable, for example, in the case of copper powder and iron powder, and must be weighed.

In depicting the future of powder metallurgy, the author is, in the writer's opinion, too conservative. The statement, too, that the cost of raw materials is the prime deterring factor may be modified. In the writer's opinion, there ranks first of all, the matter of quality, in the raw materials or powders. Price will take care of itself as manufacturing costs are decreased through volume once a good powder is achieved.

What is a good powder? A good powder is one that not only meets the physical or other required properties, but also permits setting up a briquetting press as one would set up, for example, a milling machine, planer, gear cutter, or any machine tool for straight and forward production.

The author's style is clear and clean cut, making for easy reading. Details are included, but not too many. His approach is direct, and the sequence is logical. Statements and conclusions are positive wherever merited. A big task well done.

[2] President, Amplex Division, Chrysler Corporation, Detroit, Michigan. Mem. ASME.

Books Received in Library

ENGINEERING HYDRAULICS, Proceedings of the Fourth Hydraulics Conference, Iowa Institute of Hydraulic Research, June 12–15, 1949. Edited by H. Rouse. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1950. Linen, $6 \times 9^1/_4$ in., 1039 pp., diagrams, charts, maps, tables, $15. This comprehensive reference work, written by selected authorities, constitutes the official proceedings of the Fourth Hydraulics Conference, held in 1949. Fundamental principles are emphasized throughout the thirteen chapters that deal with the principles of flow: hydraulic similitude, flow measurement, hydrology, flow of underground water, steady and unsteady flow in closed and open systems, flood routing, wave motion, sediment transportation, and hydraulic machinery. The Appendix contains a list of symbols, dimensional considerations, and the properties of common fluids.

FOUNDATIONS OF AERODYNAMICS. By A. M. Kuethe and J. D. Schetzer. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1950. Linen, $6 \times 9^1/_4$ in., 374 pp., illus., diagrams, charts, tables, $5.75. Stressing an understanding of basic concepts, this book treats perfect, viscous and compressible-fluid-flow theory with applications to problems in aeronautics and other fields of engineering. Among the topics discussed are thin-airfoil and finite wing theory, one-dimensional flow, flow around wings, shock waves, laminar and turbulent boundary layers, turbulence and transition. No previous knowledge of aerodynamics is assumed, but undergraduate physics and mathematics through advanced calculus are required. Problems are grouped in sections at the end of the text.

HIGH-SPEED DIESEL ENGINES. By P. M. Heldt. Sixth edition. P. M. Heldt, Nyack, New York, N. Y., 1950. Linen, $5^1/_4 \times 8^1/_2$ in., 500 pp., illus., diagrams, charts, tables, $6. The theory, design, application, operation, and maintenance of high-speed Diesel engines are presented, including material on the two-stroke engine, recently developed fuels, cold starting, and gas turbines. Graphs and section drawings are extensively used to illustrate the many details brought out in the text. An appendix is added to this edition which contains brief statistics of engine production, an outline of progress in the various fields of application, digests of engineering papers on Diesel topics, and brief descriptions of recent industrial products.

MATHEMATICAL THEORY OF PLASTICITY. By R. Hill. Oxford University Press, New York, N. Y.; Clarendon Press, Oxford, England, 1950. Fabrikoid, $6 \times 9^1/_2$ in., 356 pp., diagrams, charts, tables, $7. Serving as an introduction to the subject for engineers and applied mathematicians, this book presents selected topics on the theory of plasticity and its applications. Stress-strain relations, laws of yielding and work-hardening, and extremum and uniqueness theorems are developed systematically, with particular attention given to the physical basis. Several chapters are devoted to analyses of the stresses and strains in technological processes.

MECHANICAL ENGINEERING LABORATORY. By C. W. Messersmith and C. F. Warner. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1950. Paper, $8^1/_4 \times 11^1/_4$ in., 160 pp., illus., diagrams, charts, $3.50. In preparing this laboratory manual, the material usually covered in thermodynamics and heat-power engineering textbooks has been omitted wherever possible. Experiments described include the following: measurements of temperature, power, and so on; determinations of certain properties or characteristics of materials; tests on types of mechanical-engineering equipment —pumps, steam generators, and engines. The experiments are so arranged that the student must use a certain amount of initiative in the setup and operation, having been given the necessary basic information.

MECHANICS OF DEFORMABLE BODIES. By A. Sommerfeld, translated from the second German edition by G. Kuerti. Academic Press, New York, N. Y., 1950. Linen, $6 \times 9^1/_4$ in., 396 pp., illus., diagrams, $6.60. Based on the second German edition, this book is an English translation of volume two of a six-volume set. It deals with the mechanics of systems with an infinite number of degrees of freedom. Partial differential equations, vector analysis, and the fundamentals of tensor analysis are used in the mathematical methods developed in the text. Problems are collected at the end of the volume.

MODERN AIR-CONDITIONING, HEATING AND VENTILATING. By W. H. Carrier, R. E. Cherne, and W. A. Grant. Second edition. Pitman Publishing Corporation, New York, N. Y.; Toronto, Canada; London, England,

1950. Linen, 7 × 10¼ in., 574 pp., illus., diagrams, charts, tables, $10. Providing a comprehensive treatment of the whole field, this book applies existing theory to actual practice in the industry. The second edition contains new material in the chapters on estimating, oil-burner applications, panel heating, air cleaning and purification, cooling coils, central conditioning systems, and automatic control. The section on psychrometrics is entirely rewritten, and new data have been added on the subject of comfort. Special topics, such as the economics of heating and conditioning systems and the control of noise and vibration, are also dealt with.

PAPER AND PULP MILL CATALOGUE, Engineering Handbook, 1950–51, 27th annual edition, compiled by H. E. Weston. Fritz Publications, Chicago Ill., 1950. Stiff paper, 8½ × 11 in., 524 pp., illus., diagrams, charts, tables, gratis to those interested in the paper industry. The Buyers' Service Section of this annual publication contains a classified index of sources of equipment and supplies for pulp and paper mills, including a separate listing of chemicals and dyestuffs, provides an index of trade names, and gives the addresses of supply firms. There is also a section containing condensed manufacturers' catalogs, a 124-page handbook section of useful information, and a directory of institutions teaching pulp and paper manufacture.

PRINCIPLES OF SCIENTIFIC RESEARCH. By P. Freedman. Public Affairs Press, Washington, D. C., 1950. Cloth, 5½ × 8¾ in., 222 pp., diagrams, charts, tables, $3.25. The history, philosophy, psychology, planning, organization, and usefully applicable techniques of scientific research are discussed for the benefit of those entering, or concerned with, this important field. Examples are given in the last few chapters of the proper approach to a research problem in order to achieve optimum results for a minimum of time and effort expended.

RAILWAY TRACK. By K. F. Antia. Second edition. New Book Company, Ltd., Bombay, India, 1949. Cloth, 5¾ × 9 in., 416 pp., illus., diagrams, charts, tables, apply for price. Of value as a text to students and as a reference manual for railway-track specialists, this book considers various aspects of the subject with emphasis on methods practiced in India. It is divided into four parts, dealing respectively with (1) materials, design, and layout, (2) construction, maintenance, and renewal, (3) related topics such as bridge maintenance and signaling and interlocking, (4) technical-data appendixes. Track stresses are dealt with in a special chapter.

REFRIGERATION ENGINEERING. By H. J. Macintire and F. W. Hutchinson. Second edition. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1950. Linen, 6 × 9¼ in., 610 pp., illus., diagrams, charts, tables, $6.50. This revised, modernized, and expanded edition provides basic data on the essential principles of refrigeration, and includes recent advances in commercial machinery. Eight new chapters, over 70 illustrative figures, more than 30 full-page graphical solutions, and 160 new problems are provided. The new material covers the topics of reversed-cycle theory, analysis of transient phenomena, the heat pump, and radiation effects in determination of equilibrium cold-storage temperature.

REGISTRIERINSTRUMENTE. By A. Palm. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1950. Fabrikoid, 6¼ × 9¼ in., 1950. 220 pp., illus., diagrams, charts, tables, 19.50 Dm. This book is a survey of recording instruments used in science and industry. It covers instruments with typical or special properties and those of commercial importance. The first part is devoted to a general consideration of registering or tracing means, methods, and driving mechanisms. Mechanical, electrical, and optical methods of measurement are then discussed with at least one instrument of each type described. The uses of various instruments are also considered.

SELECTION AND HARDENING OF TOOL STEELS. By L. H. Seabright. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1950. Linen, 6 × 9¼ in., 263 pp., illus., charts, tables, $5. Of interest to metallurgists, tool designers, and heat-treaters, this book classifies all standard tool steels produced by companies in the United States and Canada into logical groups based on their properties and performance. Following an introductory chapter, in which the tool steels are classified, there are three main sections on water-hardening steels, oil and air-hardening steels, and high-speed and hot-work steels. Each part is then subdivided into specific groups according to composition and use.

SYMPOSIUM ON TURBINE OILS. (Special Technical Publication No. 105.) American Society for Testing Materials, Philadelphia, Pa., 1950. Paper, 6 × 9 in., 52 pp., illus., diagrams, charts, tables, $1.50. The four technical papers in this symposium present a review of progress in connection with lubrication problems of gas-turbine equipment, steam-turbine sets, industrial turbines, and marine-turbine propulsion equipment. Considerable attention is paid to inhibited turbine oils.

THEORY OF THE INTERIOR BALLISTICS OF GUNS. By J. Corner. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1950. Linen, 6 × 9¼ in., 443 pp., illus., diagrams, charts, tables, $8. This book is devoted to theoretical techniques used in the study of the phenomena that occur inside a gun or that are closely associated with it. Gun propellants, and simple and advanced ballistic methods are discussed. Similarity relations and optimum problems, the interior ballistics of leaking guns, some special types of guns, the hydrodynamic problems of interior ballistics, and heat transfer to gun barrels are among the special topics considered.

TOOL ENGINEERING, Analysis and Procedure. By L. E. Doyle. Prentice-Hall, Inc., New York, N. Y., 1950. Linen, 5¾ × 8¾ in., 499 pp., illus., diagrams, charts, tables, $6.35. Beginning with a discussion of the nature and scope of tool engineering, this book covers the diverse aspects of the current duties, responsibilities, and procedures of the tool engineer. Economic principles, estimating, planning, manufacturing and dimensioning principles, process operations, layout, tool design, and handling are covered in detail as major factors in the solution of problems that arise in tooling for efficient production. Practical examples and review questions are provided.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficultly in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING. The following Case Interpretations were formulated at the Committee meeting November 3, 1950, and approved by the Board December 29, 1950.

*CASE No. 941 (REOPENED)

(Special Ruling)

In third line of the inquiry after Par. U-68 add "or U-200." In fifth line of the inquiry change "A.S.T.M. Specification A 204–38" to" Specification SA 204–49T."

In fifth line of the reply after Par. U-68 add "or U-200."

CASE No. 1068 (REOPENED)

(Special Ruling)

In the reply, in the second item of the table, "A 133" should be changed to "A 113."

CASE No. 1117

(Interpretation of Par. U-17(a))

Inquiry: The 1950 Edition of the Unfired Pressure Vessels Code has been revised to require for unfired steam boilers a minimum thickness of ¼ in. Is this requirement applicable to unfired steam boilers built under the 1949 Edition of the Unfired Pressure Vessels Code?

Reply: It is the opinion of the Committee that the minimum thickness for unfired steam boilers required by the 1950 Edition of the Unfired Pressure Vessels Code should also be required by the 1949 Edition and to make it clear, Par. U-17(a) should be revised to read:

U-17(a) For all unfired pressure vessels, except unfired steam boilers, the

* Applies to Unfired Pressure Vessels, 1949 only.

minimum thickness of shell plates, heads, or dome plates, after flanging, shall be $^3/_{32}$ in. for welded construction, except that for riveted construction the minimum thickness shall be $^3/_{16}$ in. For unfired steam boilers the minimum thickness of shell plates, heads, or dome plates after forming shall be $^1/_4$ in. Vessels which are of a size that will not hold their shape without additional support must be provided with stiffeners so designed as to prevent distortion due to their own weight and/or to influences causing stresses other than those due to internal pressure.

(*See Proposed Revision under Unfired Pressure Vessels 1949.*)

CASE No. 1119

(*Special Ruling*)

Inquiry: May 18 per cent Cr—8 per cent Ni stainless steel which is stabilized with columbium plus tantalum be used under Code rules which are applicable to the use of stainless steel of Type 347?

Reply: It is the opinion of the Committee that 18 per cent Cr—8 per cent Ni stainless steel which is stabilized with columbium plus tantalum may be used under the Code rules which are applicable to the use of Type 347 steel with the following restrictions:

1. Material—The material shall conform to an approved specification and grade covering Type 347 alloy steel, except that the chemical composition shall be modified as follows:

Columbium.....	determination not required
Columbium plus tantalum	1.25% max 10 × carbon content min

2. Working stresses shall be the same as those for Type 347 stainless steel.

CASE No. 1120

(*Special Ruling*)

Inquiry: Is it permissible for welded construction under Sections I and VIII of the Code to use alloy steel plates containing $2^1/_4$ per cent Cr and 1 per cent Mo which corresponds to Spec. SA-213, Grade T-22? Spec. SA-213 is a specification for boiler and superheater tubes and there is no ASTM or ASME specification covering this material in the form of plate.

Reply: It is the opinion of the Committee that the intent of the Code will be met by using alloy steel plates which conform to the chemical and physical requirements and allowable stresses, of Spec. SA-213, Grade T-22, and which otherwise conform to Spec. SA-301. These alloy steel plates will be classed in "P" Number 5—"O" Number 1 of Table Q-5 in Section IX.

CASE No. 1121

(*Interpretation of Table P-5*)

Inquiry: Under Footnote 2 of Table P-2 is a provision that stresses for tubes designed in accordance with Formula C shall be taken from Table P-5 at a temperature of not less than 750 F. Where boiler tubes are so located that operating temperatures will not exceed 650 F and are not in contact with combustion gases, may the stresses permitted at 650 F be used for such tubes?

Reply: It is the opinion of the Committee that for tubes not absorbing heat and not subject to metal temperatures over 650 F, whose thickness may be computed by Formula C, the use of the stresses at 650 F in Table P-5 will meet the intent of the Code.

Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets []. Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

PAR. P-22. Add to first paragraph:

When the outside diameter of a circular boiler pressure part exceeds 5 in., the minimum thickness may be determined by the formulas in Par. P-180, but shall be not less than $^1/_4$ in.

PAR. P-112(c). Add to seventh paragraph:

except that for boiler and superheater tubes where the diameter does not exceed 4 in. and the recess for the backing ring does not exceed $^1/_{32}$ in., the reduced net section may be replaced by weld metal in the outside reinforcement.

Table P-7. Under "Pipe and Tubes," "Seamless Alloy Steel" add a line for SA-315 repeating the stresses given for SA-213, Grade T-12.

Under "Castings," "Alloy Steel," add a line for SA-217, Grade WC6 with the following stresses under the temperature columns:

14000	14000	14000	13500	12000	10300
8250	5850	3850	2200	1400	900

Under "Bolting," "Alloy Steel," delete the line for SA-315.

PAR. P-180(d). Add:

Inside backing rings may remain at the circumferential welded seams of headers designed with the increased stresses permitted in the stated paragraphs, provided such construction complies with the requirements of Par. P-112.

PAR. P-186(c). Insert as new paragraph:

(4) Unless protected by refractory material, the furnace shall not extend beyond the outside face of the tube sheet a distance greater than the thickness of the tube sheet. Any excess shall be removed before welding.

Change old paragraph (4) to (5) and add at end of its second paragraph:

but it shall not extend beyond the toe of the weld and the toe shall not project beyond the face of the tube sheet by more than $^2/_3$ in.

PAR. P-242. Add as new subparagraph:

An Adamson furnace may be assembled by welding, provided the outside edges of the flue flanges are attached to Adamson rings by full fillet welds; inside edges of the rings are welded to the flat portions of the flue flanges by full fillet welds; and the welds are stress-relieved in accordance with Par. P-108.

PAR. P-301. Add at end of first paragraph:

In the case of a single boiler and prime mover installation, the throttle valve of the prime mover is considered as the required stop valve, provided it is equipped with an "open or closed" indicator and is suitable to withstand the required hydrostatic pressure test of the boiler.

PAR. P-318. Replace the last sentence with the following:

For boilers other than those fired with spreader type stokers or with gaseous, liquid, or pulverized fuels, if pumps only are used, one shall be steam driven.

PAR. A-20(b). Revise to read:

(b) The casing of the fusible plugs shall be made of composition conforming to Specification SB-61 or from phosphor bronze rods conforming to ASTM B139-48T, provided such rods are relief annealed to the extent that specimens will pass the standard ASTM mercurous nitrate test.

Unfired Pressure Vessels 1949

PAR. U-17(a). Revise to read:

U-17(a). For all unfired pressure vessels, except unfired steam boilers, the minimum thickness of shell plates, heads or dome plates, after flanging, shall be $^3/_{32}$ in. for welded construction, except that for riveted construction the minimum thickness shall be $^3/_{16}$ in. For unfired steam boilers the minimum thickness of shell plates, heads, or dome plates after

forming shall be 1/4 in. Vessels which are of a size that will not hold their shape without additional support must be provided with stiffeners so designed as to prevent distortion due to their own weight and/or to influences causing stresses other than those due to internal pressure.

(*See Case 1117 under Interpretations.*)

Unfired Pressure Vessels 1950

PAR. UG-6(d). Transfer entire paragraph to end of Appendix B.

Add to title of Appendix B:

and the Use of Materials Not Identified as Complying with Code Specifications.

Insert "New Materials" as a subtitle under the main title and "Use of Materials not Identified as Complying with Code Specifications" as a subtitle after Par. UA-120. Transfer Appendix B to the Mandatory Section changing its designation to Appendix IV and renumber its paragraphs beginning with UA-65. Replace present Par. UG-6(d) with the following:

(d) Plate material not completely identified with any code specification may be used in the construction of unfired pressure vessels under the provisions of Par. UA-76.

Add as a new paragraph to the new Appendix IV.

UA-76 Seamless or welded tubes or pipe not completely identified with any approved Code specification may be used in the construction of unfired pressure vessels under the following conditions:

(1) If an authentic test record for each heat or heat-treating lot of material is available, proving it to have properties within the permissible range of an approved SA or SB specification.

(2) If an authentic test record is not available, or all of the material cannot be positively identified with the test record by legible stamping or marking, each length of tube or pipe shall be subjected to a chemical check analysis and sufficient physical tests to satisfy the authorized inspector that all of the material is properly identified with a given heat or heat-treatment lot, and that the chemical and physical requirements of the approved Code specification are complied with. Material specified as suitable for fusion welding, cold bending, close coiling, etc., shall be given sufficient check tests to satisfy the inspector that each length of material is suitable for the fabrication procedure to be used.

(3) If the test requirements of the approved Code specification are more restrictive than the specification or authentic tests that have been reported for the material, such more restrictive tests shall be made in accordance with the requirements of the approved specification and the results submitted to the authorized inspector for his approval.

(4) Each length of tube or pipe shall be gaged for thickness in accordance with the requirements of the approved specification. For tubes, such gaging shall be on the basis of minimum wall.

(5) After such material has been properly identified with an approved specification and the authorized inspector has been satisfied that the material complies with such specification in all respects, the testing agency shall stencil or otherwise mark as permitted by the applicable material specification, a serial "S" number on each length, or as alternately provided for small sizes in the specification, in the presence of the inspector.

(6) Suitable report forms, clearly marked as being a "Report on Tests of Non-Identified Material" shall be furnished by the pressure-vessel manufacturer or testing agency, properly filled out, certified by the testing agency, and approved by the inspector.

(7) The authorized inspector shall have the right to accept or reject the testing agency or the test results.

(8) The requirements for fabrication applicable to the specification to which the nonidentified material corresponds shall be followed and the allowable design stress shall be that given in Tables UG-23 and UG-27 for that corresponding specification.

PAR. UG-9. Make this paragraph UG-9(a) and add as a new subparagraph:

(b) Tubular products not completely identified with any code specification may be used in the construction of unfired pressure vessels under the provisions of Par. UA-76.

TABLE UG-23. Under "Bolting," "Alloy Steel," insert specification SA-193, Grade BC. Put notes (11) and (12) opposite this specification and the following stresses left to right:

20000 18375 16750

Insert note (12) after present (11) opposite each of the following eight specifications: SA-193, Grade B4, B5, B7, B7a, B11, B13, B14, and B15. In footnotes, change present note "(12)" to "(13)" and "(13)" to "(14)." Add new note (12) as follows:

(12) Between temperatures of —20 F to 400 F, stresses equal to the lower of the following will be permitted: 20 per cent of the tensile strength; 25 per cent of the yield point stress.

PAR. UG-27(b). In definition for E, third line, delete "fusion."

PAR. UG-32(c). In definition for E, fourth line, delete "fusion."

PAR. UG-34. In third definition for C, third line, delete "fusion." In fifth definition for C, first and third lines, delete "fusion." In eighth definition for C, fifth line, delete "fusion."

PAR. UG-36(b) (2). Delete the last three sentences.

FIG. UG-36.2. Delete.

PAR. UG-55(a). In second line, delete "fusion."

PAR. UG-67(b). In first line, delete "fusion."

PAR. UG-67(c). In first line, delete "fusion."

PAR. UG-76(a). In fourth line, change "gas" to "oxygen."

PAR. UG-76(c). In second line, change "gas" to "oxygen."

PAR. UG-80(d). In second line, change "parent plate" to "base metal."

PAR. UG-116(c). In fifth line, change "Fusion" to "Arc or gas."

PAR. UG-116(e). Revise to read:

(e) (1) The letters XR shall be applied under the Code symbol to those vessels of welded construction on which the principal seams have been completely radiographed.

(2) The letters PXR shall be applied under the Code symbol when only a part of the vessel has been radiographed as provided in Par. UW-11(c). The extent of radiographing and use of radiographic joint-efficiency shall be noted on the Manufacturers' Data Report.

PAR. UG-116(f). Revise to read:

(f) (1) The letters SR shall be applied under the Code symbol if the whole vessel has been stress-relieved.

(2) The letters PSR shall be applied under the Code symbol when only a part of the vessel has been stress-relieved as provided in Par. UW-10(e). The extent of stress-relieving and use of stress-relief joint-efficiency shall be noted on the Manufacturers' Data Report.

FIG. UG-118. After "W," change "fusion" to "arc or gas."

PAR. UW-1. Revise to read:

UW-1 *Scope.* The provisions of Part UW are applicable to vessels or parts of vessels fabricated by welding. The welding processes that may be used are limited to those specified in Par. UW-27.

PAR. UW-5(a). In second line, delete "fusion."

PAR. UW-5(c). In third line, delete "fusion."

PAR. UW-5(d). In second line, delete "fusion."

PAR. UW-8(a). In second line, delete "fusion."

PAR. UW-8(b). Revise to read:

(b) *Minimum Thickness of Plate.* The thickness after forming and without allowance for corrosion of all plates subject to pressure, shall be not less than 1/4 in. for unfired steam boilers and not less than 3/32 in. for Par. UW-8(b) and 3/16 in. for Par. UR-10(b). For other unfired pressure vessels, see Pars. U-2(f), 1949 Edition and UG-25(a), 1950 Edition.

PAR. UW-9(a). Revise to read:

UW-9 *Design of Welded Joints.* (a) *Permissible Types.* The types of welded joints that are permitted in arc and gas welding processes are listed in Table UW-12 together with the limiting plate thickness permitted for each type. Butt-type joints only are permitted with pressure welding processes (See Par. UW-27(2).

PAR. UW-9(b). Revise to read:

(b) *Welding Grooves.* The dimensions and shape of the edges to be joined shall be such as to permit complete fusion and complete joint penetration. Qualification of the welding procedure as required in Par. UW-28 is acceptable as proof that the welding groove is satisfactory.

PAR. UW-9(f). Revise first sentence to read: Except where specific details are permitted in other paragraphs, the design of welded vessels, in which welded joints are subjected directly to bending loads, shall be such as to keep the stresses within permissible limits, and complete joint penetration shall be obtained, with fillet welds added where necessary to reduce stress concentration.

PAR. UW-10. Replace entire paragraph with the following:

UW-10 *Thermal Stress Relieving* (a) Vessels or parts of vessels shall be thermally stress-relieved by one of the procedures prescribed in Par. UW-40 when the plate thickness, including corrosion allowance, as defined in (b) at any main welded joint in the vessel shell or head exceeds any of the following values, or when required by Par. U-2(f), UG-67, or UW-2:

(1) Zero thickness for steels conforming to Specifications SA-302, Grade B; SA-157, Grades C4 and C11; and SA-217, Grades WC-4 and WC-5; and for chrome-molybdenum steel having a chromium content greater than 0.70 per cent.

(2) 0.58 in. for steels conforming to Specifications SA-202 Grade A, SA-203, SA-204, SA-225, SA-299, and SA-301; and for any steel having a specified molybdenum content of 0.50 per cent nominal (permissible range 0.40 to 0.65 per cent) with a chromium content not greater than 0.70 per cent.

(3) 1.00 in. for steels conforming to Specifications SA-212, SA-105 Grade II, SA-181 Grade II, SA-266 Grade II, SA-27 Grade 70-36, SA-95, and SA-216 Grade WCB.

(4) 1.25 in. for all other steels that may be used in welded construction.

(5) 0.58 in. for vessels or vessel sections having an inside diameter of 20 in. or less.

(6) A thickness greater than $\frac{D + 50}{120}$ in. for vessels or vessel sections having an inside diameter D greater than 20 in.

(b) When the welded joint connects plates that are of different thickness, the plate thickness to be used in applying the requirements in (a) shall be the following:

(1) The thinner of two adjacent butt-welded plates including head to shell connections.

(2) The thicker of the shell or head plate in connections to intermediate heads of the type shown in Fig. UW-13(f).

(3) The thickness of the shell in connections to tube-sheets or similar constructions.

(4) The thickness of the shell or head plate in nozzle attachment welds.

(c) All welding of connections and attachments shall be stress-relieved when the vessel or part thereof is required to be stress-relieved by the rules in (a) with the following exceptions which apply only to materials other than those covered in (a) (1) and (a) (2):

(1) Fillet welds and groove welds not over $\frac{1}{2}$ in. in size that attach connections which have a finished diameter not greater than 2 in. and which do not form ligaments that require an increase in shell thickness. (*See definition of size.*)

(2) Longitudinal fillet and groove welds not over $\frac{3}{8}$ in. in size and circumferential fillet and groove welds not over $\frac{1}{2}$ in. in size that attach supporting members or other non-pressure attachments such as plates or structural shapes to the inner or outer surface of a vessel.

(d) Vessels or parts of vessels that have been stress-relieved in accordance with the rules in this paragraph shall again be stress-relieved after repairs or alterations that involve welding in excess of that permitted in (c).

(e) The increased joint efficiency allowed for stress-relieving in Par. UW-12 may be applied to any part of a vessel that is stress-relieved together with the welded joints attaching it to the adjoining parts.

PAR. UW-12(a). Revise to read:

UW-12 *Welded Joint Efficiencies.* (a) The maximum joint efficiencies to be used in the design of vessels or parts of vessels fabricated by an arc or gas welding process are given in Table UW-12. The joint efficiency depends on the type of joint weld and on whether or not the vessel is stress-relieved or radiographed.

TABLE UW-12. In title, change "Fusion" to "Arc or Gas."

FIG. UW-13. Add sketch from Case No. 1104 with caption: "Butt-Weld With One Plate Edge Offset."

PAR UW-15(a). In third line, change "fusion" to "arc or gas."

FIG. UW-15. In caption, delete "fusion." In drawing show weld sizes by giving leg dimensions.

PAR. UW-19. Insert new paragraph (b) as follows:

(b) Welded stays, substantially as shown in Fig. UW-19.2 and which need not be stress-relieved, may be used to stay jacketed unfired pressure vessels provided:

(1) The pressure does not exceed 150 psi.

(2) The plates do not exceed $\frac{1}{2}$ in. in thickness.

(3) The throats of the welds do not exceed the plate thickness.

(4) The inside welds are properly inspected before the attachment of the closing plates.

(5) The stresses calculated on the throat dimension of the weld do not exceed 7000 psi.

(6) The maximum diameter or width of the hole in the plate does not exceed $1\frac{1}{4}$ in.

(7) The welders are qualified under the rules of Section IX of the Code.

(8) The maximum spacing of stays is determined by the formula in Par. UG-47(a), using:

C = 2.1 if either plate is $\frac{7}{16}$ in. thick or less

C = 2.2 if both plates are more than $\frac{7}{16}$ in. thick

Change old paragraph "(b)" to "(c)."

Insert as a new illustration "Fig. UW-19.2 Use of Plug or Slot Welds for Staying Plates," corresponding to Fig. U-7 in the 1949 edition. Change the present "Fig. UW-19" and the two references to it in Par. UW-19 (1) and (2) to "Fig. UW-19.1" and "Fig. UW-19.1(c)," respectively. In drawing show weld sizes by giving leg dimensions.

PAR. UW-26(a). In second line, delete "fusion."

PAR. UW-26(b). In fifth line, change "welding operators" to "welders and welding operators."

PAR. UW-26(c). In second line, change "welding operators" to "welders and welding operators."

PAR. UW-27. Revise to read:

UW-27 *Welding Processes.* Welding processes that may be used in the construction of vessels under this Part of the Code are restricted as follows:

(1) Arc or gas welding processes are restricted to shielded metal arc, submerged arc, inert gas metal arc, atomic hydrogen metal arc, and oxyacetylene. No mechanical pressure or blows shall be applied except as permitted for peening in Par. UW-39.

(2) Pressure welding processes are restricted to forge, flash, induction, resistance, pressure thermit, and oxyacetylene.

PAR. UW-28. Revise to read:

UW-28 *Qualification of Welding Procedure.* (a) Each procedure of welding that is to be followed in construction shall be recorded in detail by the fabricator.

(b) Each such welding procedure shall be qualified in accordance with the provisions of Section IX of the Code insofar as they apply. Only Qualified Procedure Specifications shall be followed in construction.

(c) Each fabricator shall make the required tests to qualify all welding procedures to be used by his organization.

PAR. UW-29(a). In first line, change "welding operators" to "welders and welding operators." In third line, change "operator" to "welder and welding operator."

PAR. UW-29(b). In first line, change "welding operator" to "welder or welding operator." In third line, change "operator" to "welder or welding operator."

PAR. UW-29(c). In first line change "welding operators" to "welders and welding operators."

PAR. UW-29(d). In second line, change "welding operator" to "welder or welding operator."

PAR. UW-30. In first line, change "gas" to "oxygen." In fourth line, delete "gas or arc."

PAR. UW-36. Revise to read:

UW-36 *Fillet Welds* In making fillet welds, the weld metal shall be deposited in such a way that adequate penetration into the base metal at the root of the weld is secured.

PAR. UW-37(a). Revise to read:

UW-37 *Miscellaneous Welding Requirements.* (a) The reverse side of double-welded butt joints shall be prepared by chipping, grinding, or melting, so as to secure sound metal at the base of weld metal first deposited, before applying weld metal from the reverse side.

PAR. UW-37(c). Revise to read:

(c) If the welding is stopped for any reason, extra care shall be taken in restarting in order to get the required penetration and fusion. For submerged arc welding, chipping out a groove in the crater is recommended.

PAR. UW-37(f). In second line, change "welding operator" to "welder or welding operator." In sixth line, change "welding operators" to "welders and welding operators."

PAR. UW-38. Revise to read:

UW-38 *Repair of Weld Defects.* Pinholes, cracks, incomplete fusion, or other defects shall be removed by mechanical or thermal means and the joint rewelded.

PAR. UW-40(a). Revise to read:

UW-40 *Technique for Thermal Stress-Relieving.* (a) The operation of thermal stress-relieving as prescribed in Par. UW-10 shall be performed by one of the following methods:

PAR. UW-40(a) (6). Revise to read:

(6) Heating the circumferential joints of pipe or tubing by any appropriate means over a band having a width of not less than three times the greatest width of the weld groove nor less than twice the width of the completed weld. The portion outside of the heated band shall be protected so that the temperature gradient is not harmful.

PAR. UW-40(b). Revise to read:

(b) The following procedure shall be used in stress-relieving vessels of carbon or low alloy steel by any of the methods given in (a):

PAR. UW-40(d). Delete and replace with present (g) relettered.

PAR. UW-40(e). Revise to read:

(e) Vessels of different thicknesses may be stress-relieved in the same furnace charge according to the stress-relieving requirements for the thickest vessel in the charge.

PAR. UW-40(f). Delete and replace with present (h) relettered.

PAR. UW-46. In second line, delete "fusion."

PAR. UW-47. In first line, change "operator" to "welder and welding operator."

PAR. UW-47(b). In second and fourth lines, change "welding operators" to "welders and welding operators."

PAR. UW-47(c). In third and fifth lines, change "welding operator" to "welder or welding operator."

PAR. UW-50(a). In first line, delete "Fusion."

PAR. UW-52(a). In first line, delete "fusion."

PAR. UW-52(e) (3). In first and fifth lines, change "flamecut" to "oxygen cut."

PAR. UW-52(e) (4). Revise first sentence to read:

(4) Sections removed from the welded joint shall not show any types of cracks or zones of incomplete fusion or inadequate joint penetration.

PAR. UW-52(e) (5). In fourth line, change "welding operator" to "welder or welding operator."

PAR. UW-52(f). In third line, change "methods" to "procedures."

PAR. UW-52(g) (1). In thirteenth line, change "method" to "procedure."

PAR. UR-10(b). Revise to read:

(b) The thickness after forming and without allowance for corrosion of all plates subject to pressure, shall be not less than $1/4$ in. for unfired steam boilers and not less than $3/32$ in. for Par. UW-8(b) and $3/16$ in. for Par. UR-10(b). For other unfired pressure vessels, see Pars. U-2(f), 1949 Edition and UG-25(a), 1950 Edition.

PAR. UR-31(b). In third line delete "fusion." In seventh line, change "operators" to "welders."

PAR. UR-40(b). In first line, delete "fusion."

PAR. UA-4(b). In definition for E, fourth line, delete "fusion."

FIG. UA-48 (3), (4), (8), and (9). In drawing show weld sizes by giving leg dimensions.

APPENDIX A. Transfer from the Non-Mandatory to the Mandatory Appendixes, giving it the designation "Appendix V" and rearrange the definitions in alphabetical order under two groups as follows:

UA-90 *Terms Relating to Pressure Vessels*

Clad Vessel
Design Pressure
Efficiency (of a joint)
Layer or Laminated Vessel
Lined Vessel
Magnetic Particle Inspection
Maximum Allowable Working Pressure
Maximum Allowable Working Stress
Normal Operation
Operating or Working Pressure
Operating or Working Temperature
Radiographing

UA-91 *Welding Terms*

Arc Cutting
Arc Welding
Atomic Hydrogen Welding
Automatic Welding
Backing
Base Metal
Brazing
Butt Joint
Corner Joint
Double Welded Butt Joint
Double Welded Lap Joint
Edge Joint
Filler Metal
Fillet Weld
Forge Welding
Full Fillet Weld
Fusion
Gas Welding
Induction Welding
Inert Gas Metal Arc Welding
Joint Penetration
Lap Joint
Machine Welding
Manual Welding
Overlap
Oxyacetylene Welding
Oxygen Cutting
Plug Weld
Porosity
Pressure Welding
Reinforcement of Weld
Resistance Welding
Seal Weld
Semi-automatic Welding
Shielded Metal-arc Welding
Single Welded Butt Joint
Single Welded Lap Joint
Size of a Weld
Slag Inclusion
Stress-Relief Heat Treatment (Thermal stress relief)
Submerged Arc Welding
Tee Joint
Thermit Welding
Throat of a Fillet Weld
Undercut
Weld
Weld Metal
Welded Joint
Welder
Welding Operator

PAR. UA-119(a). In sixth line, delete "fusion."

APPENDIX K. In title, delete "Fusion."

PAR. UA-827(a). In second line, change "welding operators" to "welders."

PAR. UA-832. In second line, delete "electric."

FORMS U-5(A) & (B). In title, change "Operators" to "Welders and Welding Operators." Under first line, change "Process or Operator" to "Process, or Welder or Welding Operator." In third line, change "Welding Operator to "Welder or Welding Operator."

INDEX. Under "F," in first column, last item, change "welding operators" to "welders and welding operators." Under "H," delete second from last item, "fusion-welded vessels. . .UW-50." Under "I," first item under "Inspection," delete "fusion," and in sixth item under "riveted vessels," change "operator" to "welder or welding operator." Under "J," in eighth and tenth lines, delete "fusion." Under "L," delete eleventh line, "fusion welding. . .UW-2." Under "M," in item referred to "Form U-5," change "Welding Operator" to "Welders and Welding Operators." Under "Materials" in second item, delete "fusion." Under "P," in last item under "Plates," delete "fusion."

ERRATA

PAR. UA-280. Example No. 5. In the calculation for required thickness t_n, the first figure in the denominator, "14,150" should be "15,000" which will change the answer from "0.153 in." to "0.145 in."

Welding Qualifications 1949

TABLE Q-5. In Section "P" Number 4—"O" Number 1 add the following lines in their numerical sequence:

Spec. no.	Grade	Name
SA-182	F2	Chrome - molybdenum forged or rolled alloy flanges, fittings, etc.
SA-213	T22	Chrome-molybdenum alloy steel tubes
SA-217	WC6	Nickel-molybdenum alloy steel castings for fusion welding
SA-315	...	Chrome-molybdenum alloy steel pipe for high temperatures

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

EJC Recommends Four-Point Program for Optimum Use of Engineering Manpower

Survey Shows Shortages Becoming Serious

THE engineering profession, acting through the Engineering Manpower Commission of the Engineers Joint Council, recently recommended new national legislation to safeguard the nation in event of war.

The four-point program recommended by the EJC Commission is: (1) Registration of all engineers up to the age of 70; (2) establishment of a National Engineering Personnel Board to make selections of critical skills for allocation to the military, civilian defense, and industry; (3) a reserve of special skills selected by the National Engineering Personnel Board; and (4) establishment of special war-training programs to augment technical manpower of industry.

An engineer was defined by the Commission as "a qualified individual who has successfully absorbed the recognized basic training of an undergraduate engineering curriculum and who has added specialized skills and abilities through practice in industrial or military applications."

The recommendations were contained in a letter to Robert L. Clark, director, Manpower Office, National Security Resources Board, who on Sept. 6, 1950, invited EJC and several other professional organizations to prepare a program for the most effective utilization of engineers in the national effort and make recommendations as to how such a program could be administered. (See page 930, November, 1950, issue, Mechanical Engineering.)

It is expected that the EJC recommendations will be given early consideration by the 11-man Manpower Advisory Committee recently named by W. Stuart Symington, chairman, National Security Resources Board (see page 167 of this issue).

Mr. Clark's request led to appointment by EJC of a 20-man Commission under the temporary chairmanship of E. G. Bailey, past-president and Honorary Member ASME, which undertook an intensive study of the engineering manpower problem. The results of this study were announced at a public meeting of the Commission held in the Engineering Societies Building, New York, N. Y., Dec. 21, 1950.

The Commission's recommendations are based on the deep conviction that national survival "depends on superior and prior scientific and engineering skills to offset superiority of numbers which the free nations lack." Superiority of morale was not enough. The Commission therefore gave particular attention to two considerations: (1) Effective utilization and organization of skills now existing in the military and industrial groups; and (2) the expectation that by 1954 there would be a cumulative shortage of over 40,000 engineering graduates.

Shortages Confirmed

Twenty-four companies who are large employers of engineers confirmed the development of a critical shortage of engineers in response to a telegram sent on Dec. 18, 1950, by the EJC Commission. The average company has lost 10 per cent of its employees by either the draft or activities of the reserves, the survey showed.

"Sperry Gyroscope Company said it was "seriously handicapped now by shortage of engineers and technicians for current classified research development and research contracts. . . ."

The recall of reserve groups, the Dow Chemical reported, "would stop many of our research projects and make very difficult emergency production."

The Ford Motor Company has been affected "to a slight degree by lack of skilled engineering personnel in the local labor markets."

In the General Electric Company" the shortage of engineers was not only acute but becoming desperate. It was impossible to fill needs in design and research. Extreme shortages in schools make it impossible to even begin to fill needs and losses to Armed Services."

The Babcock & Wilcox Company wired that "unless regulations are modified to permit retention of necessary engineers we simply will be unable to produce the equipment expected from us in this national emergency."

Decreasing Enrollments

In its report to Mr. Clark, the EJC Commission emphasized the need for increased engineering-college enrollments if engineering staffs in the Army, Navy, and industry were to be sufficient for an all-out effort.

Attached to the Commission's letter was a report on "The Developing Critical Shortage of Engineers" by S. C. Hollister, dean, College of Engineering, Cornell University, which predicted that the expected supply of engineering graduates by 1952 would be equal to about one third of the estimated need of industry and the military. (The full text of Dean Hollister's report appears on pages 121–122 of this issue.)

Six Committees Plan

In its letter to Mr. Clark, the EJC Commission commented on various manpower plans before the country. It expressed approval of recommendations made to Maj. Gen. Lewis B. Hershey, director of Selective Service System, by the Six Scientific Advisory Committees representing agriculture, engineering, the healing arts, humanities, physical sciences, and social sciences. These recommendations were: (1) that students who are deferred to pursue courses have added to "their period of Selective Service liability a period equal to the time they were deferred for training; (2) Selective Service should create a classification to be known as II-A(S) to cover all students who have demonstrated educational aptitude of potential value to the national health, safety, and interest; (3) a general classification and a record of previous educational accomplishment be combined in deciding when a student is of special promise in science or the professions; (4) students eligible for II-A(S) classification should be certified by an accredited educational institution. Any student registered as II-A(S) would, under the plan, remain in this classification for four months after completion of his scholastic training.

The EJC Commission found these recommendations sound because: (1) They are based on the policy for continuing training of engineering and specialized personnel; (2) they make use of training facilities which would have to be duplicated by the military for postinduction training; (3) they provide for both military and civilian needs for engineering manpower; (4) they are flexible and can be adjusted when necessary; and (5) they solve the student problem within the framework of existing legislation.

The Conant Plan

With reference to the statement by James B. Conant, president, Harvard University, calling for induction for a two-year period of all men without exception as soon as they reached 18, the EJC Commission commented as follows: "The Commission recognizes the desirability of the universality of obligation for service in some essential form by the entire citizenry. It believes that any such plan as the Conant Plan must be modified to recognize the following principles:

"1 The fundamental policy of continuing training of qualified scientific, technical, and engineering personnel, needed in the years ahead, in the interest of national security, health, and welfare.

"2 The fundamental policy of providing

for both the military and industrial needs for scientific, technical, and engineering personnel."

Extended ROTC

The EJC Commission also took under consideration proposed legislation now before Congress which would extend ROTC training to provide for continuation of training in the college of men in uniform. The plan would pay qualified young men $50 to $60 a month and all expenses during a four-year course.

The EJC Commission did not find the legislation satisfactory in present form because the program would drain off into the Armed Forces most of the men qualified for engineering courses. Instead, the Commission recommended that suitable legislation be provided for personnel needed by industry "since a scientific and engineering war cannot be won without a scientific and technically staffed industry backing up the military."

EJC Manpower Commission

Members of the EJC Commission are: E. G. Bailey, temporary chairman; Donald B. Prentice, secretary; *American Society of Civil Engineers:* Carl Beam,[1] ASCE staff, New York, N. Y.; George W. Burpee, Coverdale and Colpitts, New York, N. Y.; D. W. Winkelman, president, D. W. Winkelman Company, Inc., Syracuse, N. Y.; and W. N. Carey, executive secretary, ASCE; *American Institute of Mining and Metallurgical Engineers:* George B. Corless,[1] Standard Oil Company (N. J.), New York, N. Y.; Max W. Lightner, Carnegie-Illinois Steel Corporation, Pittsburgh, Pa.; Harry J. O'Carroll, Kennecott Copper Corporation, New York, N. Y.; and Edward H. Robie, secretary, AIME; *The American Society of Mechanical Engineers:* Carey H. Brown, Eastman Kodak Company, Rochester, N. Y.; George W. Codrington, General Motors Corporation, Cleveland, Ohio; R. E. Gillmor, vice-president, Sperry Corporation, New York, N. Y.; C. E. Davies,[1] secretary, ASME. *American Institute of Electrical Engineers:* O. W. Eshbach, dean, Northwestern Technological Institute, Evanston, Ill.; A. C. Monteith,[1] vice-president in charge of engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa.; H. A. Winne, vice-president, General Electric Company, Schenectady, N. Y.; and H. H. Henline, secretary, AIEE. *American Institute of Chemical Engineers:* W. I. Burt, B. F. Goodrich Company, Cleveland, Ohio; F. J. Curtis, vice-president, Monsanto Chemical Company, Washington, D. C.; C. G. Kirkbride, vice-president, Houdry Process Corporation, Marcus Hook, Pa.; and S. L. Tyler[1] secretary, AIChE. *The American Society for Engineering Education:* Henry H. Armsby, specialist in engineering, Office of Education, Washington, D. C.; F. M. Dawson, dean, State University of Iowa, Iowa City, Iowa; S. C. Hollister,[1] dean, college of engineering, Cornell University, Ithaca, N. Y.; and Thorndike Saville, dean, college of engineering, New York University, New York, N. Y.

[1] Members of Working Committee, EJC Engineering Manpower Commission.

Eleven Chosen to Advise U. S. on Manpower

THE National Security Resources Board recently named eleven men prominent in education, industry, and science to serve on the Board's Scientific Manpower Advisory Committee.

W. Stuart Symington, NSRB chairman, said the committee's recommendations would be a guide to President Truman and the Board in formulating a policy to obtain maximum defense help from scientists, engineers, and other technical personnel.

Mr. Symington said this would include plans for training an adequate supply of such personnel to meet future needs.

Charles A. Thomas, executive vice-president of the Monsanto Chemical Company, is chairman of the Committee. The eleven who will serve with him are:

Chester I. Barnard, president of the Rockefeller Foundation and General Education Board, New York, N. Y.; J. Douglas Brown, dean of the faculty, Princeton University, Princeton, N. J.; Vannevar Bush, president of the Carnegie Institution, Washington, D. C.; Ralph Conner, vice-president of the Rohm and Haas Company, Philadelphia, Pa.; Lee Dubridge, president of the California Institute of Technology, Pasadena, Calif.; Everett Lee De Golyer, oil geologist, engineer and consultant, Dallas, Texas; Jacob Devers, major general, United States Army (ret.), Washington, D. C.; Gordon Gray, president of the University of North Carolina, Chapel Hill, N. C.; Ben Moreell, board chairman and president of the Jones & Laughlin Steel Corporation, Pittsburgh, Pa.; J. C. Warner, president of the Carnegie Institute of Technology, Pittsburgh, Pa.; and Harry A. Winne, Fellow ASME, vice-president of the General Electric Company, Schenectady, N. Y.

National Water Policy Based on River-Basin Concept Recommended

President's Commission Submits 445-Page Report

ENACTMENT of a single national water-policy law based on the river-basin concept to control the activities of existing and future Government departments dealing with national water resources was one of the 70 recommendations made by President Truman's Water Resources Policy Commission in a 445-page report made public recently. This is the first of a three-part report which when completed will compose the most comprehensive and authoritative study of national water resources in the country's history.

The President's Commission, headed by Morris L. Cooke, Fellow ASME, consulting engineer, Philadelphia, Pa., was formed last year to study extent and character of Federal Government participation in major water-resources development and to recommend desirable legislation or changes in existing legislation relating to the development, utilization, and conservation of national water resources.

Regional Development

Recognizing that river basins were the natural subdivisions of the country's water resources and that watersheds were the natural units in those river basins, the Commission recommended that all water resources planning and operation be handled on a multiple-purpose river-basin basis. It justified this concept of planning as follows:

"Irrigation and drainage, navigation and flood control, the maintenance of underground water levels, the control of stream pollution resulting from human, animal, and industrial wastes, the generation of electric power, the protection of salmon and fish resources, the provision of ample domestic water supply—all of these purposes have legitimate claims within any one basin; but if one is developed without regard for its effects on the others, conflict and losses will result."

Ten River Basins

The Commission's report was based on the study of the following ten river basins: Columbia, Central Valley of California, Colorado, Rio Grande, Missouri, Ohio, Tennessee, Alabama-Coosa, Potomac, and Connecticut.

Setting up separate river-basin commissions was proposed in the report, consisting of representatives from all responsible Federal agencies. These commissions would coordinate the surveys, construction activities, and operations of the Federal agencies in the several basins, under guidance of independent chairmen appointed by the President.

Financing of river-basin programs would be a part of the Federal investment program, starting with a standard form of "investment-appraisal statement" for each project, and setting up six-year river-basin capital-investment programs with annual budgets prepared to show requested appropriations for river basins by projects and agencies.

The report recommends that Congress, in appropriating for river-basin programs, clearly state how much of the total investment is to go to different benefits, stressing the importance of a system of multiple-purpose basin accounts to permit clear identification of costs, benefits, and repayments.

The Commission says that the orderly formation of national water resources programs requires establishment of a Federal board of review to work with the river-basin commissions in developing uniform standards for all water resources work.

Federal Power Policy

In commenting on Federal power policy as it relates to water resources, the report states "while private operation of power systems has predominated throughout the history of the power industry, in this country we have had in fact a mixed system in which publicly operated power systems have played an important and influential part."

The Commission noted that the country's power supply is predominently operated by private corporations, that out of 67 million kilowatts installed in all generating stations supplying the public in the middle of 1950, the privately owned total is 53.5 million kilowatts against 13.5 million kilowatts in public plants.

By 1970, according to figures supplied by the Federal Power Commission, the nation will require a total installed central station power capacity of 160 million kilowatts to supply total energy requirements in the neighborhood of 725 billion kilowatthours annually.

That means an increase of about 93 million kilowatts of capacity and some 400 billion kilowatthours a year in electric energy over the next 20 years.

"To assure the country's ability to meet this demand, "the report continues, "will require the joint efforts of both public and private power enterprises. The additional steam electric capacity may be expected to be a main responsibility of private power systems. The relationship of hydroelectric power to multiple-purpose development means that the public contribution will be particularly in water power."

Regional power resources should be viewed as a whole in order to achieve broad objectives, the report states—"regardless of ownership, it should be possible in every region to secure for all the benefits of careful integrated power system development, either by agreement or by common ownership of facilities."

EJC Contributes to Study

A uniform national policy to eliminate "excessive and unsound" practices by competing federal agencies was one of the principal recommendations in a 250-page statement reflecting the considered opinion of the American engineering profession. The statement was prepared by the Water Policy Panel of the Engineers Joint Council and was one of many submitted to the President's Commission by trade associations and professional societies concerned with water resources. (See pages 673–674 of the August, 1950, issue of MECHANICAL ENGINEERING.)

The President's Commission

Members of the President's Commission are: Morris L. Cooke, Fellow ASME, consulting engineer, Philadelphia, Pa. (chairman); Paul S. Burgess, dean, College of Agriculture, University of Arizona, Tucson, Ariz.; Lewis Webster Jones, president, University of Arkansas, Fayetteville, Ark.; Samuel B. Morris, Department of Water and Power, Los Angeles, Calif.; Leland Olds, Commissioner in Charge of Studies, New York; Roland R. Renne, president, Montana State College, Bozeman, Mont.; and Gilbert F. White, president, Haverford College, Haverford, Pa.

Federal Power Expansion Opposed by Private Utilities

THE recommendations of the President's Water Resources Policy Commission revealed hostility toward independent enterprise, according to James W. Parker, Hon. Mem. and past-president ASME, and president of The Detroit Edison Company, Detroit, Mich. Mr. Parker, on behalf of the privately owned electric groups, made a statement shortly after release of the 445-page report of the President's Commission, in which he contended that the document constituted one more expression of hostile attitude toward independent enterprise. He said it was "mainly a restatement of the unfair Federal power and water-resources policy favored by the 'public power' boosters in Government departments and bureaus."

Charging the Commission with having "failed completely in its mission of establishing a workable pattern for an acceptable national power policy," Mr. Parker, representing the electric companies' Public Information Program, declared:

Claim False Thesis Repeated

"This group is headed by Morris L. Cooke and includes ex-Federal Power Commission chairman Leland Olds. It clings, in its recommendation for development of hydroelectric power, to the false and oft-repeated thesis that the industrial economy of the United States has been retarded from the beginning by insufficient development of the country's power resources.

"The Cooke-Olds group takes little account of the fact that 55 per cent of the nation's hydroelectric power has been developed by private industry and that the industry is willing and competent to develop more—without expenditure of public money.

"Also the Commission attaches far too little importance to the tremendous program of electric-power development which has been and is being carried out by the electric industry—without help from the Government."

Mr. Parker maintained that the Commission findings "amount to an extension of 'Government from Washington' despite overwhelming testimony urging water development and supervision by local administrators which the Commission itself heard in a series of public meetings over the country."

Dislocation of Industry Would Result

As spokesman for private utilities, Mr. Parker contended the Commission disregarded much that it heard and "obviously has not considered that the establishment of new 'valley authorities' will produce tremendous dislocation of industry—which may someday result in a good many 'ghost towns.'"

Unless "hampered by excessive and ill-conceived interference," Mr. Parker said, the industry, prepared to take on a 15,000,000,000 expansion program, "will be more than able to keep pace with the nation's industrial development both in war and peace."

UNESCO Book-Coupon Scheme Successful

IN the two years of its operation, the book-coupon scheme of UNESCO—the United Nations Educational, Scientific and Cultural Organization—has moved more than one million dollars' worth of books, educational film, and scientific apparatus across economic barriers caused by national currency restrictions.

The scheme allows an engineer resident in any of the 20 countries co-operating in the book-coupon scheme to purchase with the currency of his own country a book published anywhere in the world. He does so by first purchasing UNESCO book coupons and then by using these coupons to pay the bookseller.

So far, India has been the best customer for UNESCO coupons, buying $175,000 worth. The United States, the largest bookselling country in the scheme, is now becoming a purchaser as well. Several major American booksellers have bought coupons and negotiations are under way with a number of American libraries, including the Library of Congress, interested in using coupons for their own foreign book acquisitions.

The extension of the coupon idea to purchases of educational films and scientific equipment was undertaken recently. The first customer for film coupons was the Egyptian Ministry of Public Health, which ordered $1200 worth to buy 19 documentaries from Encyclopaedia Britannica Films in the United States. They covered such subjects as home nursing, first aid, the common cold, and dental care. The first science coupon was bought by the Technical University of Istanbul, Turkey. It was used to obtain a harmonic analyser—a form of computing machine—from a firm in Switzerland.

At present, 13 countries are co-operating in purchases of industrial films and 11 countries are doing so for scientific apparatus.

Education

A SCHOOL of Humanities and Social Studies having equal status with the Schools of Science, Engineering, and Architecture and Planning, was recently established at the Massachusetts Institute of Technology. M.I.T.'s fourth school will have the responsibility of providing the strongest possible program in general education for students in science, engineering, and architecture.

James R. Killian, Jr., president of the Institute, in making the announcement, emphasized that the new school "does not mean that M.I.T. plans to develop a school or college of liberal arts or to give degrees in the liberal arts." M.I.T., he said, would remain an institution of limited objectives, offering as it has for many years the same program centered around science, engineering, architecture, and management. The new school was designed, he said, to enable the Institute to broaden and deepen its activities in these fields and to educate men to be effective citizens as well as effective professional practitioners.

American Management Association Looks Ahead to Defense Production Program

WHAT the current defense production program means to American industry was the general topic for the Production Conference of the American Management Association held at The Drake, Chicago, Ill., Dec. 11-12, 1950.

The national defense situation was far different than in 1940 because the nation must expand production for national defense at a time when the economy was operating at almost maximum levels for nondefense purposes, H. B. McCoy, assistant administrator, National Production Authority, Washington, D. C., told the conference.

NPA Described

Summarizing the work of the National Production Authority, Mr. McCoy explained that the NPA was established by the Secretary of Commerce to administer responsibilities delegated to that department by the President in accordance with the Defense Production Act. The first NPA order, he said, required users of the most important industrial materials to keep reasonable inventories. The second order provided a preferred rating for military procurement. Another series of orders required producers to set aside a given percentage of their output of a specific material to fill rated orders. To govern the use of copper, aluminum, and nickel, NPA has issued another set of orders. These orders, Mr. McCoy said, affect large segments of business and have been misunderstood by many. To illustrate NPA's approach to the use problem, Mr. McCoy explained how the nickel-distribution order was promulgated. First, he said, the defense requirement for nickel was examined. This included the needs of the Munitions Board and that of the stockpiling program. The NPA order allocated 35 per cent of the amount of nickel available to this country to the readily identified defense needs. The balance of 65 per cent was available for all nonmilitary uses. The nickel distribution order specified that nickel consumers use only 65 per cent of what they used in the base period, the first six months of 1950. Thus the amount of nickel available for nonmilitary use was distributed fairly among consumers for all purposes.

Large and small business, he continued, had equal access to the supply of nickel based on their past pattern of consumption. The nickel order did not itself curtail the use of nickel—rather, it did two things: (1) Provided for defense requirements and (2) laid down rules for distribution of nickel supply among all users.

NPA was also undertaking a materials-conservation program. Mr. McCoy said two methods were under consideration: (1) Through specification controls curtailing the quantity of materials used in a specific application; and (2) by prohibiting the use of materials in a product where less scarce materials were available as a substitute.

Mr. McCoy concluded by saying that individuals can be sure that they will have much less or none at all of many things they are able to buy today to satisfy personal desires.

Developing First-Line Supervision

Speaking at the same conference, E. H. Reed, manager, education and training, International Harvester Company, Chicago, Ill., claimed that American management was guilty of poor selection of supervisory employees and neglect of educational training, and chided American managers for calling too many conferences. Business, he said, has become a social institution in that it has a definite responsibility for human development. To preserve the American way of life, industry must do more for employees than provide them with jobs. "It must train them to be good citizens as well as good workers. This means training the whole man."

Referring to the American propensity for conferences, Mr. Reed said that unless conferences are organized to the point that people were motivated to do something different from what they did before little was accomplished.

Expansion in Aluminum

The United States will be making seven times as much aluminum in 1953 as it was at the beginning of 1940, Richard S. Reynolds, Jr., president, Reynolds Metals Company, Richmond, Va., told the Conference. In 1952 aluminum production will be increased 71 per cent above that of January, 1950, as compared with plans for expansion of 9 per cent over mid-1950 by the steel industry, and a 20 per cent increase in aviation gas production. The tremendous demand on the aluminum industry, Mr. Reynolds said, can be attributed to many new uses for the light metal in the preparedness program. Aluminum helmets are needed for fighting men. Aluminum is also used for pontoon bridges, the bazooka, and portable pipelines. Plans are being made for aluminum jeeps, trucks, and 106-millimeter guns to be used as air-borne equipment.

Much of the anticipated increase in production can be accomplished only by building additional plants, Mr. Reynolds declared. He called on American industry to concentrate first on the reduction of waste. There was too much waste of materials and effort in production operations. He referred especially to production loss as the result of machines being down for maintenance and repair. He called also for greater efficiency through simplification of operations. "There are a lot of experts who are selling complications, but not enough are selling simplification."

Economies in Product Design

The engineer plays an important role in the development of low-cost products, according to John Van Hamersveld, supervisor, design cost control, The Glenn L. Martin Company, Baltimore, Md. Because engineering of a product sets the cost pattern, the engineer holds the key to low-cost production. In his company, he said, a consulting group of design-cost-control engineers has been established to assist the designer in achieving economical producibility and low cost. These engineers were responsible for maintaining simplicity of configuration, ease of fabrication, minimum number of parts, ease of assembly, efficient production breakdown, and standard components and accessories. During the last year the company achieved an actual saving of $312,000 or over $44,000 per man as a result of 82 written studies.

Steel Founders' Society Discusses Cast-Weld Advantages

RESULTS of research in product development are contributing to the solution of many complex engineering problems it was reported at the Fifth Annual Technical and Operating Conference of the Steel Founders' Society of America held at the Hotel Carter, Cleveland, Ohio, Nov. 9, 1950. Redesign of castings for cast-weld construction and accounts of successful cast-steel welding procedures were some of the topics which received the most attention.

The Society represents a majority of the steel foundries in North America and more than 90 per cent of steel-casting companies.

30 Papers Presented

During the three-day session more than 30 technical papers, discussing specific developments arising out of the 25 national research products sponsored by the Society, were read.

The use of the cast-weld process for replacing parts previously cast was recommended by several speakers. Such redesign depended on cooperation among customers, designers, and the foundries. Most castings, according to A. H. Suckow of the Symington Gould Corporation, Depew, N. Y., especially those of a complex nature, lend themselves to redesign as cast-weld structures, but close study of the functional construction of design features was required.

The redesign procedure calls for (1) reduction in manufacturing costs by division of a casting to eliminate coring; (2) economical distribution of metal for best weight-strength ratio and avoidance of stress concentration; (3) holding welding costs to a minimum by proper location of welds; and (4) stress-relieving the welded assembly.

Mr. Suckow reported an interesting conversion of freight-car center fillers and strikers to cast-weld structures which resulted in a reduction of core weight from 308 to 3 lb per casting, a reduction of 638 in. in lineal weld, and a 30 per cent reduction in weight.

Steel Foundries Well Equipped

Another speaker pointed out that steel foundries were in an advantageous position to take on the cast-weld process because they are usually so equipped that additional facilities are not needed. Frequently such foundries have better facilities to weld medium and large structures than fabrication shops. Foundries, furthermore, have proper heat-treating and pressure-blasting equipment for stress relaxation and cleaning weldments which many welding shops lack.

American Standards Association Reports Approval of 149 Standards in 1950

Procurement Benefits From Standardization Described

THE American Standards Association approved 149 standards in 1950, according to Harold S. Osborne, chief engineer of the American Telephone and Telegraph Company, and vice-president of the American Standards Association, New York, N. Y. Mr. Osborne reported this fact at the opening session of the National Standardization Conference, held recently in New York, N. Y. The Conference was sponsored by the American Standards Association, which is the national clearinghouse for industrial, engineering, safety, and consumer standards in the U. S.

Of these 149 American Standards, Mr. Osborne said, 66 are new and 83 are revisions of standards previously approved. In addition, he said, the Association has reviewed and reaffirmed 24 standards without change. The 66 new standards bring the total of American Standards in effect to 1139.

Sectional and technical committees of the ASA, Mr. Osborne said, held about 300 meetings dealing with the formation of standards during the year. He declared that the various branches of the telephone industry have 160 representatives working on committees formulating standards under ASA procedures.

Under the procedures of the ASA, The American Society of Mechanical Engineers shouldered full responsibility for processing and expediting the work of more than 30 ASA sectional committees.

As examples of new American Standards approved this year, Mr. Osborne cited three standards for dimensions and construction of steel electric conduit; a standard for electric ranges; a standard for gray finishes for industrial apparatus and equipment; a safety code for mechanical refrigeration; and a safety standard for industrial power trucks. Other groups of standards refer to photography, motion pictures, building materials, petroleum products, gas piping and appliances, tools for use in machine work, and several other fields.

It was reported that American industry showed an accelerated interest in international standardization during the year. The ASA, as the U. S. representative of the International Organization for Standardization, has been authorized to participate in such projects as plastics, boilers, measurement of liquid flow, graphical symbols, and the determination of viscosity. In June an international conference was held by British, Canadian, and American representatives to work out unification of the dimensions of bolt and screw heads and nuts.

Thomas D. Jolly Elected President

Thomas D. Jolly, Mem. ASME, vice-president, Aluminum Company of America, Pittsburgh, Pa., was elected ASA president for 1951. This is Mr. Jolly's third one-year term.

Procurement Benefits

As a result of standardization studies of procurement costs begun six months ago throughout its 38 plants and branches, the Ford Motor Company is expecting to save several hundred thousand dollars annually, according to George M. Rice, of the Lincoln Mercury Division, Ford Motor Company, Detroit, Mich.

Mr. Rice, who was one of the speakers at the conference, explained that these benefits would accrue from a standardization program applied to purchasing of such items as brooms, screw drivers, wrenches, shovels, pliers, and other tools.

Merely by giving up company standards for carbon brushes used on electric motors and adopting industry-wide standards for these items, his company was saving 25 to 30 thousand dollars annually. This policy reduced from 900 to 700 the types of brushes purchased and enabled brush manufacturers to pass on to customers a savings of 25 per cent.

In a recent study of quick-loading operations, it was decided to replace a special-length company-standard drill with a drill having industry-wide standard. Mr. Rice estimated the annual saving from this step to be about $3500.

Mr. Rice called attention to the savings possible through standardization of shipping containers, which reduced the number of sizes used by the Ford Motor Company from 145 to 60 cartons. A saving of $150,000 per year was estimated from this measure.

Smaller companies who could not afford specialized personnel responsible for the procurement of materials were advised to refer to government specifications, American standards bulletins, and ASTM for comparable standards, and to specifications and standards set up by the basic industries as one of the best ways in purchasing operations.

Plastics Industry Needs Mechanical Engineers

IN planning careers young mechanical engineers should not overlook the opportunities that abound in the plastics industry, according to H. L. Bullock, Mem. ASME, consulting engineer, Bullock-Smith Associates, New York, N. Y.

Mr. Bullock, who is a member of the education Committee of the Society of the Plastics Industry, is working to enlist the co-operation of engineering schools in a program to include basic plastics courses in mechanical-engineering curriculums. Another SPI project is to offer guidance to students who plan to enter the plastics industry after graduation. The SPI Education Committee is currently conducting a survey of engineering employers to determine future requirements for engineering personnel.

Mechanical engineers have major responsibilities in all of the major divisions of the plastics industry: The basic manufacture of plastics materials; design and manufacture of plastics fabricating equipment; and the fabrication of plastics products, Mr. Bullock said.

While the first division is relatively small and depends mainly on chemical engineers, the design and manufacture of plastics-fabricating machinery is a field mechanical engineers can claim for their own. This division of the industry feels the greatest need for young imaginative mechanical engineers. It was the fabricators, however, he said, who represent the largest numerical division of the industry and one in which jobs are plentiful for engineers qualified to design special machinery, dies, and new products, and to supervise production and maintain facilities. Rapid advancement to managerial levels is common in this division for good mechanical engineers.

For those interested in knowing more about the industry and how to prepare for responsibility, two booklets have been prepared by the SPI Education Committee. "Plastics—The Story of an Industry" is a 36-page booklet which describes the industry and basic plastic materials in common use. "A Program for Plastics Education in Science and Engineering" is intended for engineering-school faculties and students. It recommends inclusion of plastics and other high polymers in basic undergraduate courses, introduction of elective courses in plastics, and encouragement of these on plastics.

Copies of both booklets may be obtained free from the Society of the Plastics Industry, Inc., 295 Madison Avenue, New York 17, N. Y.

Asphalt Research

ESTABLISHMENT of a National Asphalt Research Center at The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa., was announced recently.

Set up on a nationwide scale, with sponsoring companies representing oil, roofing, molded products, linoleum, sealing compounds, and allied industries, the basic purpose of the new center will be to further the development of a scientific technology which will permit the formulation of better asphalts for specific purposes and the development of new applications for asphalts.

ASRE Honors Freon Developers

THE three men principally responsible for the development of the Freon family of refrigerants, considered by many as the most important single contribution in the last 20 years to the growth and advancement of the refrigeration industry, were honored by the American Society of Refrigerating Engineers whose annual meeting was held recently in New York, N. Y. A certificate of recognition was presented to Thomas Midgley, Jr., posthumously, and to Albert L. Henne and Robert R. McNary, by C. F. Kettering, Fellow ASME, research consultant, General Motors Corporation, who instigated the research that led to the discovery of the refrigerants.

Bureau of Standards Fifty Years Old in March

THE year 1951 marks the fiftieth anniversary of the National Bureau of Standards. A number of the principal scientific and technical organizations of the nation, in recognition of the role of the Bureau in science, have planned meetings in Washington in 1951 to honor the Bureau's Semicentennial.

Created by Act of Congress on March 3, 1901, the Bureau is the principal agency of the Federal Government for fundamental research in physics, mathematics, chemistry, and engineering. The Bureau's activities are thus largely concerned with the physical sciences although the close interrelationships of the major fields of science preclude the drawing of sharp lines of distinction. Considerable work, for example, is undertaken in biochemistry and biophysics, particularly projects relating to materials, processes, and instrumentation.

Measurement Standards Maintained

All working standards in research laboratories and industry are calibrated in terms of the national standards of physical measurement which the Bureau maintains. In addition, the Bureau carries on necessary research leading to improvements in such standards and in related measurement methods and instruments. New standards, methods, and instruments, in keeping with demands for greater precision and the opening up of new fields of science and industry, are also objects of research.

An equally significant aspect of the Bureau's work is that concerned with specific research and development projects in the physical sciences and mathematics. Some of these projects are related to fundamental standards, properties of materials, and physical constants, as well as measurement problems. For example, the development of the atomic clock is directly related to the Bureau's interest in a better standard of time and frequency, and it is also linked to problems in the field of microwave spectroscopy. Others of these projects range in subject matter from pure research in mathematics, in nuclear physics, and in supersonic aerodynamics to the development of guided missiles, proximity fuses, and automatic electronic computing machines.

15 Divisions Established

The scope of the Bureau's work is suggested by the names of its fifteen divisions: electricity, optics and metrology, heat and power, atomic and radiation physics, chemistry, mechanics, organic and fibrous materials, metallurgy, mineral products, building technology, applied mathematics, electronics, ordnance development, radio propagation, and missile development. The divisions, in turn, consist of several sections—totaling 108—organized as logical units of the divisions. In addition to laboratory work, the Bureau, by virtue of its staff and facilities, is called upon to render scientific advisory services to the Government and industry. Its participation in the activities of scientific and engineering societies and bodies, both nationally and internationally, is necessarily extensive and varied.

AEC School Seeks Enrollees

APPLICATIONS are now being received by the Oak Ridge School of Reactor Technology, Oak Ridge, Tenn., for enrollment in the 1951–1952 session, beginning Sept. 10, 1951. This school was established at the Oak Ridge National Laboratory in March, 1950, under sponsorship of the U. S. Atomic Energy Commission. Its purpose is to train engineers and scientists in the field of reactor theory and technology, in preparation for their employment in this field by the AEC or its contractors.

The Oak Ridge School of Reactor Technology will enroll students of outstanding qualifications who hold, or will receive by September, 1951, bachelor's or master's degrees in chemistry, engineering, metallurgy, or physics. A limited number of recent college graduates will be accepted under Category A in the status of student-employees of the Oak Ridge National Laboratory, and will be paid a monthly stipend for a twelve-months' period, beginning September, 1951.

Provision is also made for trainees sponsored by government agencies and industrial organizations connected with or interested in the AEC reactor-development program, Category B. Applications for enrollment under this category must be made by the firms or agencies employing the applicants. Such students remain on the payrolls of their home organizations.

Much of the material presented in the curriculum of the Oak Ridge School of Reactor Technology will be classified; hence all enrollments are contingent upon a personnel-security investigation.

Men trained in chemistry, engineering, metallurgy, or physics are much in demand in the reactor-development program. It is the purpose of the Oak Ridge School of Reactor Technology to provide engineers and scientists with sufficient background in reactor technology and allied subjects to become effective as research, development, and design personnel in reactor development.

Further information and application forms may be obtained by writing to the Director, Oak Ridge School of Reactor Technology, Post Office Box P, Oak Ridge, Tenn. Category for which application is requested must be specified. These applications must be filed with the director of the school by April 1, 1951.

First Western Meeting Planned by ASME Applied Mechanics Division

THE first ASME Applied Mechanics Division Western Meeting is to be held at Stanford University, Stanford, Calif., June 22–23, 1951. The meeting will overlap by one day the fourth annual Heat Transfer and Fluid Mechanics Institute which is scheduled for June 20–22, at Stanford University. The overlap will provide an opportunity for members of both groups to meet informally and to attend a wider variety of sessions. The sessions of the two meetings will run independently of each other.

The annual National Conference of the Applied Mechanics Division, which is held in the East or Middle West, will not be held in 1951 because of the First U. S. National Congress of Applied Mechanics, which convenes in Chicago, Ill., June 11–16. Because of the long-felt demand for an annual western meeting of the ASME Applied Mechanics Division, it was decided that the starting of such meetings should not be postponed. The western meeting is being organized by the Applied Mechanics Division West Coast Committee, which is composed of R. G. Folsom, chairman, University of California; R. Bromberg, University of California (Los Angeles); J. N. Goodier, Stanford University; and M. S. Plesset, California Institute of Technology. J. N. Goodier is chairman of the Special Committee for the 1951 Stanford Meeting.

The purpose is to provide better opportunity for western engineers to attend an annual conference on applied mechanics and to present the results of original research in that field. While the meeting is under ASME sponsorship, membership in the Society is not a requirement for participation either as author or as auditor.

The general subjects are those found in the ASME *Journal of Applied Mechanics*, except that they will be limited mainly to the mechanics of solids—dynamics (including vibrations), elasticity, experimental stress analysis, strength properties of materials, and plasticity. The Heat Transfer and Fluid Mechanics Institute already provides annual opportunity for western presentation of papers in other fields of mechanics.

Acceptance of papers offered for the meeting is dependent on the favorable judgment of the reviewers. The panel of reviewers will, in general, be the same as that of the Applied Mechanics Division as a whole. Acceptance by the West Coast Committee will be equivalent to acceptance by the Division, and will constitute acceptance for the *Journal of Applied Mechanics* when the manuscript is submitted for both presentation and publication. The Executive Committee of the Applied Mechanics Division has ruled that any paper accepted by either the West Coast Committee or the Division can, if the author so desires, be presented at an eastern as well as at a western meeting.

Papers proposed for the meeting should be sent to J. N. Goodier, division of engineering mechanics, Stanford University, Stanford, Calif.

They should be sent as early as possible to allow adequate time for submitting them to the panel of reviewers.

To expedite the planning of the conference, prospective authors should send advance notice at once, including the title and a brief summary of the paper.

The tentative program will be published in a later issue.

International Engineering Union Planned

PLANS for a Union of International Engineering Organizations were virtually completed recently when a draft constitution was approved by the representatives of more than twenty international engineering and scientific organizations who attended a conference at UNESCO House, Paris, France, Oct. 9–13, 1950.

The Union will formally come into being when the executive bodies of ten of the participating organizations decide to join the Union.

According to the constitution, the Union will act as a clearinghouse for information pertaining to international engineering congresses. It will co-ordinate activities of international groups, particularly with respect to programs and dates of congresses. Another of its responsibilities will be to foster new international organizations in fields not adequately serviced by existing ones.

The Union was first suggested at the General Conference of UNESCO held in Mexico City, Mexico, in 1947, as a way to meet the need for a top-level body which co-ordinates international relations among engineering bodies.

In order to obtain an informal exchange of views on the possibilities of the proposed union, UNESCO appointed a Temporary Advisory Committee for Engineering Sciences which met for the first time in Paris, July 11–13, 1949. American engineers were represented by H. V. Coes, Fellow and past-president of The American Society of Mechanical Engineers.

The Committee confirmed the need for an international union and recommended that delegates of international bodies be called for a conference as soon as possible to lay the ground work for the proposed union. The Committee met again in March 6–8, 1950. At this meeting William N. Carey, secretary, American Society of Civil Engineers, represented American engineers.

The Committee worked up the draft of a constitution, decided who should be represented at the proposed conference, and when the conference should be convened.

In October, the Conference of International Engineering Organizations met to consider the draft constitution. Every provision was carefully studied, particularly Chapter I of the document which defined the objectives. Majority of the delegates were in favor of the Union.

New Brazilian Engineering Building

THE Engineering Club of Rio de Janeiro, Brazil, will soon have a new 25-story home. The cornerstone of the new structure was laid in December, 1949. The club will occupy the upper six floors. The building will also house offices of the Brazilian Federation of Engineers and the Executive Committee, UPADI, Pan-American Union of Engineering Associations.

Dispersal of Major Target Areas Proposed

A PROGRAM to disperse major target areas in the United States by redirecting new plant construction and housing activity into the creation of new towns in outlying parts of metropolitan areas was proposed recently by the American Institute of Architects, Washington, D. C.

The program, to which the entire January issue of the AIA journal is devoted, was characterized by E. R. Purves, executive director AIA, as the "only feasible pattern for a bomb-proof civilization."

"The authority of modern weapons may make it necessary to impose ceilings on the growth of our largest and most vulnerable cities," Mr. Purves stated. "By channeling the new growth of metropolitan districts into outlying communities of substantial but limited size, clearly and widely separated by agricultural and park zones, we can reduce the number of worth-while targets in an urban nation such as ours to an absolute minimum," Mr. Purves explained.

Industrial Research Fellowships

ARMOUR Research Foundation of Illinois Institute of Technology, Chicago, Ill., is offering a number of industrial research fellowships in physics, chemistry, metallurgy, ceramics, mechanics, and electrical engineering, to begin in September, 1951.

Those persons awarded fellowships will attend Illinois Institute of Technology half-time and work in the Research Foundation half-time in a graduate program leading to advanced academic degrees. They are employed full time by the Foundation during the summer.

Fellowships begin at the start of the school semester and continue through the summer for approximately 21 months until the end of the second academic year. Awards are made on a competitive basis to U. S. citizens under 28 years of age holding a bachelor's degree from an accredited engineering or scientific school or liberal arts college with a major in the sciences.

In addition to tuition, fellows receive $150 a month during the first academic year, $275 a month and a two-week vacation during the summer, and $175 a month during the second academic year. The Foundation awarded five fellowships in 1950.

Application forms may be obtained from the Office of Admissions, Graduate School of Illinois Institute of Technology. Applications received prior to March 15 will be given first consideration.

Salaries

A BUREAU of Labor Statistics Survey covering 42,000 of the nation's outstanding scientists showed that half of them were employed by colleges and universities and drew a median salary of $4860 a year.

The 27 per cent who work in private industry have a median annual salary of $7070 while the 13 per cent in government draw $6280. The other 10 per cent either is self-employed or is employed in such jobs as scientific writing.

Engineering Literature

Solar Heating

A NEW bibliography on domestic and industrial applications of solar heating was recently issued by the Engineering Societies Library, 29 West 39th Street, New York, N. Y. The bibliography, entitled "Bibliography on Domestic and Industrial Applications of Solar Heating," contains 150 annotated references listing most of the important English and foreign papers published on the various aspects of solar heating between 1930 and the middle of 1950. Part I includes general and historical articles as well as papers on various industrial applications such as utilization of solar energy for boilers; metallurgical furnaces; drying in the chemical, ceramic, and food industries; electric power generation; refrigeration; distillation; etc. Part II has been devoted to the important fields of solar heating of houses by the different methods of storing solar heat, the design and construction of solar-oriented houses, and the design, construction, and use of domestic solar water-heating devices. Price is $2.

Other ESL bibliographies available are:

Bibliography No. 1. Filing Systems for Engineering Offices. 41 references. 1948 $2.00.

Bibliography No. 2. Prestressed Reinforced Concrete. 190 references. 1948. $4.00.

Bibliography No. 3. Precision Investment Casting by the Lost Wax Process. 111 references. 1949. $2.50.

Bibliography No. 4. Pallets Used in Moder Materials Handling. 114 references. 1949 $2.00.

Bibliography No. 5. Machinery Foundations; Design, Construction; Vibration Elimination. 120 references. 1950. $2.00.

Bibliography No. 6. Non-Metallic Bearings. 101 references. 1950. $2.00.

Bibliography No. 8. Management of Construction Jobs. *In preparation.*

Heat Transfer

THE Engineering Experiment Station, University of Delaware, recently issued its Bulletin No. 2, "Heat Transfer and Pressure Drop During Viscous Flow Across Unbaffled Tube Banks."

The Bulletin reports the work of Olaf P.

Bergelin, associate professor of chemical engineering; Allan P. Colburn, chairman, Engineering Experiment Station; and Harold L. Hull, research fellow in chemical engineering, carried on under the auspices of the Heat Transfer Division of The American Society of Mechanical Engineers. Some of the results of this work have been published in brief papers in ASME Transactions in 1949 and 1950. Bulletin No. 2 expands these reports and provides additional experimental data and graphs showing effects of variables. Copies may be obtained from the University of Delaware, Engineering Experiment Station, Newark, Del. Price is $1.

Abbreviations

AN American Standard, Abbreviations for Use on Drawings, Z32.13–1950, was recently published by the American Standards Association, New York, N. Y.

A revision of the 1946 edition, the new document is the result of collaboration with the standardization agency of the National Military Establishment, interested industries, and trade and professional organizations. It is expected that there will be complete agreement on abbreviations for words appearing both in the ASA and military standard, MIL-STD-12A.

The abbreviations listed in the 31-page standard are shortened forms of words or expressions used on drawings and are not intended for use in texts or equations.

Copies may be obtained from ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price per copy is $1.

Welding

AN American Standard, Safety in Electric and Gas Welding and Cutting Operations, Z49.1–1950, was recently published by the American Welding Society, New York, N. Y. Based on the American War Standard published in 1944, the new standard covers regulations for safe installation and operation of welding equipment for all arc, gas, and resistance welding processes. The standard also includes recommendations for fire prevention and protection of personnel, for whom eye protection and clothing requirements are prescribed. Of particular interest are the ventilation requirements which have been considerably modified and more clearly stated than in the previous document.

Copies of the 42-page standard may be obtained from American Welding Society, 33 West 39th Street, New York 13, N. Y. Price is 50 cents.

Meetings of Other Societies

Feb. 4–9
American Society for Testing Materials, petroleum products and lubricants meeting, Shoreham Hotel, Washington, D. C.

Feb. 10
Edison Pioneers, 33rd annual meeting, commemorating Thomas Alva Edison's birthday, North Ballroom, Hotel Astor, New York, N. Y.

Feb. 19–22
American Institute of Mining and Metallurgical Engineers, annual meeting, Hotel Jefferson, St. Louis, Mo.

Feb. 19–22
Technical Association Pulp and Paper Industry, annual meeting, Hotel Commodore, New York, N. Y.

Feb. 21–23
American Society of Civil Engineers, Houston convention, Rice Hotel, Houston, Texas

Feb. 26–March 2
American Management Association, personnel conference and seminar, Palmer House, Chicago, Ill.

(For ASME Calendar of Coming Events see page 178)

Notes on Coming Meetings

Power

THE fourteenth annual Midwest Power Conference will be held at the Sherman Hotel, Chicago, Ill., April 4–6, 1951.

Roland A. Budenholzer, Mem. ASME, professor of mechanical engineering, Illinois Institute of Technology, Chicago, Ill., is director of the annual conference on production, transmission, and distribution of power.

The three-day meeting is sponsored by the Institute and 18 midwestern universities and professional societies, including the Chicago Section of The American Society of Mechanical Engineers. More than 3000 power engineers from all parts of the United States and Canada are expected to attend.

A ten-man industry committee, each member of which represents a phase of the power industry, aids Illinois Institute in planning the conference.

Instruments

THE Instrument Society of America, Pittsburgh Section, and the Carnegie Institute of Technology are planning a two-day conference on instrumentation for the iron and steel industry to be held in Pittsburgh, Pa., March 28–29, 1951. Co-operating with the sponsor organizations will be the local chapters of the American Chemical Society, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Society for Metals, American Society for Testing Materials, American Welding Society, the Association of Iron and Steel Engineers, and the Engineers Society of Western Pennsylvania.

Further information may be obtained through the general chairman, L. M. Susany, Carnegie Library, 440 Forbes Street, Pittsburgh, Pa.

* * *

A CONFERENCE on Electrical Instrument Design sponsored by the Institution of Electrical Engineers will be held in the Institution Building, London, England, May 28–30, 1951. The program consists of four technical sessions at which 11 papers will be presented on the following topics: Trends in Modern Instrument Design and Construction, Limits of Measurement Present and Future, Materials and Components, and Techniques in the Field of Radiation.

Engines

AN International Internal Combustion Engine Congress is being planned for Paris, France, May 8–19, 1951, by engine manufacturers in Scandinavia, the United Kingdom, France, and the United States. The program will include technical sessions, tours to French industries, and social events.

Metals

THE American Society for Metals technical sessions at the seventh Western Metal Congress and Exposition to be held March 19–23, 1951, in the Auditorium and Exposition Hall, Oakland, Calif., are being set up along lines to interest and assist mechanical and other engineers of the West.

ASM technical sessions will be devoted to various industries, such as aircraft, oil, large machinery, small equipment, and shipbuilding. Other engineering groups will present papers and exhibits devoted to mining, chemical, manufacturing, and other industries.

Among the seminars being arranged the following will be of interest: failures resulting from general corrosion, stress-corrosion, corrosion-fatigue, and corrosion problems in the aircraft and oil industries. Clyde E. Williams, Mem. ASME, director, Battelle Memorial Institute, Columbus, Ohio, will be one of the speakers at the corrosion seminar.

Electrical Show

FIFTH Annual Industrial Electrical Show, to be sponsored by the Electrical Maintenance Engineers Association of Southern California, will be held in the Shrine Convention Hall, Los Angeles, Calif., March 15–17, 1951. The show is a service to buyers and sellers of electrical and allied industrial equipment.

Building Research

A COMPREHENSIVE Building Research Congress will take place Sept. 11–20, 1951, in London, England. The congress will review the progress made in research in relation to architecture, building, and the associated branches of civil engineering.

Technical sessions will be arranged in three divisions holding concurrent meetings: Division 1, engineering and structural aspects of building; division 2, building materials; and division 3, factors which influence the comfort and efficiency of the people in the buildings. Many interesting excursions have been planned.

For further information queries should be addressed to the Organizing Secretary, Building Research Congress, 1951, Building Research Station, Watford, Herts., England.

People

Forrest Nagler Elected Fellow ASME

FORREST NAGLER, chief mechanical engineer, Allis-Chalmers Manufacturing Company, West Allis, Wis., was recently elected to the grade of Fellow ASME. He was born in Freeport, Mich., April 21, 1885. He received a BS degree in mechanical engineering from the University of Michigan, majoring in hydraulic and marine engineering. In 1906 he joined the Allis-Chalmers Manufacturing Company where he was employed as a graduate student in the foundry and marine shop.

From that time until 1930 he remained with the company, principally on hydraulic-power work. In 1930 he went with the A. O. Smith Corporation, Milwuakee, Wis., and was engaged in development and research work. From 1933 to 1941 Mr. Nagler was chief engineer with the Canadian Allis-Chalmers, Ltd., Toronto, Ont., Can. In 1942 he returned to the United States as chief mechanical engineer with the Allis-Chalmers Manufacturing Company, at West Allis, Wis., in which capacity he serves at the present time. More recently his duties included those of manager and chief engineer of the atomic-power department.

During the recent war Mr. Nagler's principal assignment was in connection with the production of the heavy machinery used for producing the atomic-bomb material. This work was concluded with a trip to witness the second (underwater) burst at Bikini.

He is the inventor of the Nagler type of axial-flow high-speed hydraulic-turbine runner and has contributed many papers to professional journals. He served three years in the First Wisconsin Cavalry, has specialized in rifle shooting, and is the author of technical books on archery and its application to big-game hunting.

Mr. Nagler became a member of the ASME in 1918. He was a member of the Hydraulic Division, Executive Committee, 1937–1938, and chairman of that Committee, 1939–1940. He was a sponsor of the Committee on Hydraulic Prime Movers. In 1948 he was nominated to serve for two years as regional vice-president, Region VI, ASME. Mr. Nagler was awarded a life membership, in ASME in 1921, for distinguished service, and for the best paper presented before the Society, entitled "A New Type of Hydraulic-Turbine Runner," which was published in ASME Transactions, vol. 41, 1919. He is also a member of ASCE, and the Triangle and Pi Tau Sigma fraternities.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

VANNEVAR BUSH, 1950 JOHN FRITZ MEDALIST

Parsons Honored

A WINDOW in Westminster Abbey, London, Britain's national shrine, memorializing Sir Charles Algernon Parsons, engineer and inventor who died in 1931, was dedicated in the presence of Britain's leading scientists and engineers on Oct. 5, 1950. The window is situated on the north side of the nave of the Abbey.

Parsons, who was an honorary member of The American Society of Mechanical Engineers, built the first turbogenerator, was responsible for the first application of the steam turbine to ship propulsion, and contributed to many other fields.

Sir Frank Smith, speaker at the dedication, told of the difficulties Parsons encountered in trying to displace the reciprocating engines in the British Navy at a time when these prime movers were considered entirely satisfactory.

"With a boldness that amazed everyone, he planned and built a small vessel only 100 ft in length which he named the *Turbinia*. Its hull, propeller, and engines were all designed by him. He relied entirely on his own knowledge and the results of his own researches. There were many serious setbacks, but, as usual, Parsons overcame them all. The *Turbinia's* speed was demonstrated in a striking way at the Royal Navy Review at Spithead in 1897, in honor of the Diamond Jubilee of Her Majesty Queen Victoria. The little *Turbinia* charged down the line of cruisers and battleships at what was then the amazing speed of 30 knots, and demonstrated that she was easily the fastest craft ever constructed. Soon afterward the Admiralty ordered two destroyers with steam turbines, and in a few years, the superiority of the steam turbine for naval purposes was established beyond doubt."

A brief account of Parson's experimental work upon which the *Turbinia* was based was published on page 585, July, 1947, issue of MECHANICAL ENGINEERING.

Vannevar Bush Receives John Fritz Medal

VANNEVAR BUSH, president, Carnegie Institution, Washington, D. C. was named recently to receive the John Fritz Medal for 1950. The presentation was scheduled to be made during the annual winter general meeting of the American Institute of Electrical Engineers, Hotel Statler, New York, N. Y., Jan. 22–26, 1951.

The latest of numerous honors bestowed on Dr. Bush is for "outstanding scientific contributions to his country and to his fellow men," and was awarded jointly by the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, and The American Society of Mechanical Engineers.

The Medal Award was established by associates and friends of the industrialist, John Fritz, Honorary Member ASME, and awarded to him in 1902 on his 80th birthday. In the intervening years the nation's most distinguished scientists and engineers have received this honor, including George Westinghouse, Alexander Graham Bell, Thomas A. Edison, George W. Goethals, Orville Wright, Guglielmo Marconi, Herbert Hoover, and Charles F. Kettering.

Many honorary degrees and medals, including the Holley Medal of The American Society of Mechanical Engineers, have been bestowed on Dr. Bush in the past four decades.

A graduate of Tufts College in 1913, Dr. Bush has earned doctorates in engineering at Harvard and Massachusetts Institute of Technology, and has been awarded honorary degrees by a score of the nation's leading colleges and universities.

Gail A. Hathaway Heads Engineering Delegation

GAIL A. HATHAWAY, assistant to chief of engineers, War Department, Washington, D. C., and president of the American Society of Civil Engineers, was named in December, 1950, as chairman of the U. S. delegation to the sectional meeting of the World Power Conference held in Delhi, India, last month. The appointment of Dr. Hathaway for this post was recommended to the State Department by the Engineers Joint Council in a resolution which urged the appointment of engineers as official heads of U. S. delegations to international engineering meetings. Dr. Hathaway will also be the official EJC delegate to the Delhi conferences.

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GEORGE C. LAUGHLIN, Mem. ASME, assistant superintendent, Structural and Mechanical Division, Commonwealth Edison

Company, Chicago, Ill., was recently elected first vice-president for 1951 of the Illinois Engineering Council. At the same time the following list of newly elected officers was announced: Alois W. Graf, president; R. A. Lonier, second vice-president; and John A. Harrington, secretary-treasurer.

* * *

WILLIS McGERALD PEIRCE, assistant to the general manager of the technical department of the New Jersey Zinc Company, Palmerton, Pa., has been elected president of the American Institute of Mining and Metallurgical Engineers for 1951 and will take office on Feb. 20, 1951, at the Institute's annual meeting in St. Louis, Mo. At the same time the election of Joseph L. Gillson and Michael L. Haider as vice-presidents and directors of AIME for three years was also announced.

The Institute also elected six new directors to serve for three-year terms: Thomas G. Moore, Charles E. Lawall, John F. Myers, Fay W. Libbey, Albert C. Rubel, and Leo F. Reinartz.

* * *

DONALD L. HERR, Mem. ASME, of the Hughes Aircraft Company, Culver City, Calif., was the recipient of one of the A. Cressy Morrison prizes for 1950, awarded by The New York Academy of Sciences, at the annual dinner and meeting of the academy, held on Dec. 6, 1950, at the Waldorf-Astoria Hotel, New York, N. Y.

* * *

KARL T. COMPTON, Mem. ASME, chairman of the Corporation of Massachusetts Institute of Technology, was awarded the 1950 Hoover Medal for distinguished public service. The selection was announced by Scott Turner, chairman of an award board for the American Institute of Electrical Engineers, the American Society of Civil Engineers, The American Society of Mechanical Engineers, and the American Society of Mining and Metallurgical Engineers.

The medal was scheduled for presentation at the winter meeting of the American Institute of Electrical Engineers held at the Statler Hotel, New York, N. Y., Jan. 22–26, 1951. Dr. Compton is the 12th engineer to receive the medal since it was presented first in 1930 to former President Hoover for his civic and humanitarian achievements.

Dr. Compton was also awarded the first $1000 William Procter Prize for Scientific Achievement, on Dec. 29, 1950, in Cleveland, Ohio, by the Scientific Research Society of America (RESA) which administers the prize.

KARL T. COMPTON, 1950 HOOVER MEDALIST

DOGWOOD TREES IN BLOOM IN ATLANTA ADD TO THE BEAUTY OF THE CITY. SCATTERED BLOSSOMS ARE PROMISED FOR THE ASME 1951 SPRING MEETING WHICH JUST PRECEDES THE HEIGHT OF THE DOGWOOD SEASON (SEE PAGE 176)

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SAMUEL L. HOYT, Battelle Memorial Institute, Columbus, Ohio, has been awarded the Outstanding Achievement Medal of the University of Minnesota, Minneapolis, Minn. His research during the twenties led to the development of Carboloy—the cemented tungsten carbide which, among other things, gave U. S. industry a superior tool material for cutting and drawing operations. He is the founder of the department of metallography at the University of Minnesota, of which he is a graduate. He is known for his work in welding technology at Battelle and now acts as technical adviser on varied metallurgical problems. He presented an early paper, "Carboloy and Tungsten Carbide Tools," before the ASME in 1928.

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J. H. KING, vice-president, The Babcock & Wilcox Company, New York, N. Y., was recently elected president of the Society of Naval Architects and Marine Engineers for the years 1951 and 1952.

* * *

EUGENE CASSON CRITTENDEN, associate director of the National Bureau of Standards, Washington, D. C., has retired after more than 41 years of service at the Bureau. Dr. Crittenden is noted for his achievements in the measurements and standardization of light. Another far-reaching scientific achievement has been his contribution to the establishment of absolute electrical units based on the fundamental units of length, mass, and time. On Jan. 1, 1948, by his strategic marshaling of international organizations, Dr. Crittenden succeeded in having these electrical and photometric standards adopted on a worldwide basis. On July 29, 1950, Congress passed a law which officially sanctioned adoption of these units.

* * *

WILLIAM L. BATT, SR., past-president and Hon. Mem. ASME, former president of SKF Industries, Philadelphia, Pa., was named as United States member of the newly organized North Atlantic Defense Production Board by Secretary of Defense George C. Marshall. The board will have the vital mission of co-ordinating national rearmament production programs of the twelve North Atlantic Treaty countries. The aim is to increase production goals, encourage more efficient and co-operative use of their collective resources, and break production bottlenecks as they arise. Mr. Batt has been in London, England, since September, 1950, as chief of the Economic Co-Operation Administration's mission to Britain. He will continue in that post in addition to his new duties.

* * *

WILLIAM P. LEAR, director of research and development, Lear, Inc., Grand Rapids, Mich., Los Angeles, Calif., and Elyria, Ohio, was named the recipient of the 1950 Robert J. Collier Trophy, by the National Aeronautic Association, Washington, D. C., for his outstanding achievement in the development, perfection, application, and production of the Lear F-5 Automatic Pilot and Automatic Approach Control Coupler System, which makes possible the safe landing of jet aircraft regardless of extreme weather or visibility conditions. President Truman presented the trophy to Mr. Lear on Dec. 15, 1950, in Washington, D. C.

ASME NEWS

ASME 1951 Spring Meeting in Atlanta, Ga., to Be a Triple-Feature Event

THE 1951 Spring Meeting of The American Society of Mechanical Engineers to be held at the Atlanta Biltmore Hotel, Atlanta, Ga., April 2–5, 1951, promises to be one of those rare events which unite in one program all levels of interest within the Society. Because of careful planning of officers of Region IV and the Atlanta Section, the 1951 Spring Meeting has been enlarged into a triple-feature event by scheduling the Region IV Administrative Committee Meeting in Atlanta on Sunday, April 1, and the Region IV Student Branch Conference on Monday, April 2. Technical sessions are being arranged so that those of major interest to students will take place on Tuesday after the Student Branch Conference is concluded. The 1951 Spring Meeting, will, in effect be a convocation of Region IV leadership on the national, regional, and student-branch level and yet hold sufficient interest to attract attendance from members of other Regions.

Some idea of what can be expected in the way of a technical program can be had from the programs of the Power, Management, and Machine Design Divisions which are far enough along to permit comment.

Power

The Power Division is planning four sessions. Two papers on recent advances in mercury-boiler development and one describing natural steam power plants in Italy are scheduled for the first session. The second session will take up cyclone furnaces, effect of taper on screw-thread load distribution, and steam-generating station as a source and sink for the heat pump. An interesting feature of the power program will be a symposium on cooling towers. Two representatives each from the manufacturing, consulting, and operating fields will take up current problems.

Management

The tentative management program calls for three sessions and a luncheon on Wednesday at which Prof. F. F. Groseclose, Georgia Institute of Technology, Atlanta, Ga., will talk on "The Importance of Southern Industry in National Economy." The sessions will take up such topics as: Integration of organization and management; status of scientific management in the South; the engineer's role in area developments; and statistical analysis of time and motion study, department-store engineering, and others.

Machine Design

The Machine Design Division is planning a session co-sponsored by the National Junior Committee and the Education Committee in which opportunities for young engineers in the machine-design field will be described. A second paper during the same session will take up determination of effective strained length of standard steel bolts.

Other professional divisions and committees which will sponsor sessions in Atlanta are: Fuels, Heat Transfer, Industrial Instruments and Regulators, Materials Handling, Petroleum, Production Engineering, Textiles, Wood Industries, Junior Committee, and Safety Committee.

Industrial Atlanta

Not the least reason for attending the Spring Meeting is the opportunity to become acquainted with the industrial and cultural life of one of the South's great cities. Atlanta is not only the center of a spiderweb of railroads embracing the Southeast but also the center of a network of highways, and bus and air-transport lines. Atlanta is the third largest telegraphic center in the world. Atlanta also serves as southeastern headquarters of practically every company engaged in nationwide business. Her 1575 factories turn out 3000 different products.

In Atlanta was fought one of the great battles of the war between the states. Visitors can recapture the crucial days of that conflict by viewing the two chief memorials to the Confederate cause: the cyclorama painting of the Battle of Atlanta and the Stone Mountain Confederate Memorial.

Atlanta's cultural monuments, its many superb golf courses, and the beauty of its heavily wooded residential sections are worth knowing.

Plant Trips

Members who have not yet visited Atlanta will be impressed with the industrial vigor of the South. An interesting series of plant-inspection trips are being arranged for those who want to inspect Atlanta's production facilities at firsthand. Trips will be made to Electric Storage Battery Company, the Coca-Cola Company plant, Atlantic Steel Company, and several other plants.

Atlanta is known as "the Dogwood Capital of the World" and members are assured that while April 1 is early for dogwood blooms, it is expected that those attending the ASME Spring Meeting will find enough scattered blossoms to serve as a preview of Atlanta's beauty during the dogwood season.

HENRY MARX, MEM. ASME, PRESIDENT, THE G. A. GRAY COMPANY, CINCINNATI, OHIO, WAS RECENTLY PRESENTED WITH A FRAMED CERTIFICATE FOR BEING THE OLDEST MEMBER OF THE ASME IN RESPECT TO YEARS OF MEMBERSHIP

(Mr. Marx actually is a charter member and has been a member of the Society for 70 years. He is 92 years old and although he does not recall Thomas Edison personally, he does know that Edison sat in at the early meetings which resulted in the formation of the Society.)

AERIAL VIEW OF ATLANTA, GA., WHERE THE 1951 SPRING MEETING WILL BE HELD, APRIL 2–5

Second National Conference Planned by ASME Process Industries Division

MECHANICAL-engineering contributions to the solution of industrial-pollution problems will be the theme of the second annual conference of the Process Industries Division of The American Society of Mechanical Engineers to be held at the Lord Baltimore Hotel, Baltimore, Md., April 17–19, 1951.

The ASME Process Industries Division was organized in 1934 and currently has a membership of 3000 mechanical engineers operating and designing mechanical equipment for such industrial processes as air conditioning, refrigeration, distillation, evaporation, drying, fluids handling, food manufacture, mechanical separation, sanitation, water conditioning and wastes treatment, and manufactured and natural gas

The Division's first national conference held in Pittsburgh in 1950, uncovered wide interest among mechanical engineers in a program which would funnel into the literature technical papers on problems confronting engineers in the process industries.

ASME members who are interested in the Division's activities, but who have not yet become affiliated with it, are urged to write to J. B. Chamberlain, Chilean Nitrate Sales Corporation, 120 Broadway, New York 5, N. Y., secretary of the Division.

The tentative plans for the 1951 conference call for five technical sessions, a welcome luncheon, a banquet, and a series of plant trips to representative industries of Baltimore. Many of the papers will center about problems relating to abatement of air and stream pollution.

While specific papers cannot be announced, some tentative commitments have been received.

A paper on electrostatic precipitation will be presented. One session will be devoted to industrial hygiene with particular reference to plant hazards introduced by toxic gases. Other papers to be presented are on such subjects as equipment for measuring industrial wastes, evolution of a bladeless surge and trash pump, and air conditioning of factories. Another paper will describe a new scavenging device which may prove useful in removing oil slicks from American harbors. A high light of the technical program promises to be a panel discussion on air pollution at which experts from several industrial centers will exchange latest experiences.

Arrangements for the program are in charge of S. B. Sexton, chairman, Arthur Gompf, and Harland Hyde, of the ASME Baltimore Section, and J. H. E. Fedeler, chairman, E. L. Knoedler, and L. A. Dorgan, of the ASME Process Industries Division.

ASME Region VIII to Hold Meeting in Kansas City, April 16–19

REGION VIII of The American Society of Mechanical Engineers, composed of all or parts of the states of Wyoming, Colorado, New Mexico, Oklahoma, Kansas, Arkansas, Missouri, Louisiana, and Texas, will hold its second purely regional meeting at the Roosevelt Hotel, Kansas City, Mo., April 16–19, 1951.

Oriented on a regional rather than on a national basis, the meeting will present a program aimed to stimulate interest in Society affairs by providing an opportunity for local engineers to discuss engineering matters of regional interest. The first such meeting, held in Dallas, Texas, in 1950, demonstrated that the regional-meeting idea had many advantages.

Ten technical sessions are planned for the 1951 meeting. Four of these sessions will be scheduled for Monday, April 16, three for Tuesday morning, and three for Wednesday morning. Inspection trips are planned for the afternoons of Tuesday and Wednesday. Three such trips have been scheduled; one to the new Hawthorne Station of the Kansas City Power and Light Company; another to the Vendo Company of Kansas City, manufacturers of automatic vending machines; and the third, a combined trip to Midwest Research Institute and the Linda Hall Library, one of the country's fine technical libraries. The Midwest Research Institute is a research organization engaged in private and governmental research.

While the details of the technical program have not yet been filled in by R. P. Hahn, papers chairman for the meeting, some titles have been announced. C. N Kimball of Midwest Research Institute will present a paper on "The Research and Development of Resources." The engineering staff of the Boeing Aircraft Company in Wichita, Kan., will present an interesting paper on the Boeing gas turbine.

Another paper definitely scheduled is on "Welding, Stress Relieving, and Field Testing of High-Temperature and High-Pressure Piping."

Still in the tentative stage are plans for several social events. These may include a dinner and noon luncheons with short talks by guest speakers. ASME student-member attendance is planned for the Tuesday luncheon.

The following persons are in charge of the meeting: General chairman, Chester Cotter; vice-chairman and secretary, C. E. Brown; meetings and papers, R. P. Hahn; hotel, E. M. Bruzelius; registration, Newby Miller; entertainment, T. C. Cheasley; inspection trips, E. L. McDonald; publicity, Martin Goland; finance, L. T. Mart; student activities, C. R. Green; and ladies program, Mrs. T. C. Cheasley.

ASME Pittsburgh Conference Program Takes Shape

THE Pittsburgh Mechanical Engineering Conference sponsored by the Pittsburgh Section of The American Society of Mechanical Engineers will be held in the William Penn Hotel, Pittsburgh, Pa., April 19–20 1951. The theme of the conference this year will be "Pittsburgh Engineering Accomplishments" and will cover recent mechanical-engineering developments which have taken place in Pittsburgh and vicinity and those to which Pittsburgh engineers and organizations have contributed.

Six professional societies will participate in the conference by sponsoring technical papers. They are: American Society of Lubricating Engineers, Engineering Society of Western Pennsylvania, Society for the Advancement of Management, American Society of Heating and Ventilating Engineers, American Materials Handling Society, and the American Society of Refrigerating Engineers.

Commitments from authors have already been received for papers on the following subjects: Design and lubrication of bearings; interesting aspects of several recent construction jobs; economics of machinery replacement; design of the heating and ventilating system for the Greater Pittsburgh Airport; aluminum panels for cooling and heating of buildings; material handling in the new Fisher body plant at Pittsburgh; blowers, refrigeration, and heating of wind tunnels; turboexpanders for refrigeration; the Elramus Power Station; and railroad locomotive power developments. A feature of the technical program will be a symposium on metalworking.

The social high light of the conference will be the banquet on Thursday, April 19, in the ballroom of the William Penn Hotel. All members of participating societies have been invited to attend. It is expected that ASME Pres. J. Calvin Brown will be the guest of honor. As in the past, the banquet will provide the occasion for presentation of awards to engineers prominent in the Pittsburgh area.

Nominations Sought for ASME 1951 Awards

ALL members or agencies of the Society such as Committees, Sections, and Professional Divisions, are encouraged to submit nominations for the various awards not later than March 1 of each year. Each nomination should be supported by the following: (1) Full statement of the training, experience, and notable contribution of the nominee; (2) statement of the basic reasons for submitting the nomination and for believing the nominee is eligible for the honor; (3) other information or reference which will assist the Board on Honors in considering the nominee.

It is absolutely essential that such nomination carry the present title and company connection of the candidate, or if he is retired, his present residence address.

Those wishing to make a nomination should first obtain a copy of a Manual on ASME

Honors and Awards. This may be had by writing to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

Awards for 1950

Honorary Memberships: Five may be awarded each year. The Constitution provides the recipients shall be persons of "professional eminence." These awards are not limited to Society members. A nominee must be endorsed by 25 members of the Society.

ASME Medal: This award is made for distinguished service in engineering and science, and may be conferred in recognition of general service in science having possible application in engineering.

Holley Medal: The award is made for some "great or unique act of genius of an engineering nature that has accomplished a great and timely public benefit."

Worcester Reed Warner Medal: This award is made to honor the author of an outstanding contribution to permanent engineering literature. Permanent engineering literature may be a book, a series of books, a single paper, or a series of papers, which have been recognized as important additions to engineering literature by the profession.

1951 RAC Meetings Announced

BETWEEN March 11 and May 8, 1951, all Sections of The American Society of Mechanical Engineers will send delegates to eight Regional Administrative Committee Meetings, one to each of the ASME Regions, to discuss regional and national problems, as well as to consider and act upon items submitted by various sections. This material is compiled by the Agenda Committee.

This year Region IV will hold its RAC meeting as part of the events planned for the 1951 ASME Spring Meeting, Atlanta, Ga., April 2–5, 1951. Region VIII will hold its RAC meeting as part of the three-day Region VIII annual meeting, Kansas City, Kan., April 16–19, 1950.

In the fall of each year the ASME Agenda Committee invites each section to suggest topics for discussion for the next Conference. These items are tabulated by the Agenda Committee and sent to each of the ASME sections for approval. Items approved by 15 or more sections are placed on the final agenda for consideration by the Regional Administrative Committees. Items approved by a majority of the RAC meetings are then placed on the agenda of the Regional Delegates Conference. Each delegate to these meetings and the Conference receives a mileage and per diem allowance from the National Society toward his expenses. Two delegates from each section attend the Regional Administrative Committee Meetings, at which two delegates from each region are selected to carry actions of that region to the Regional Delegates Conference held at the time of the Semi-Annual Meeting. The actions of this Conference are referred to Council for final disposition.

ASME Mexico Group Reports Active Season

MEMBERS of The American Society of Mechanical Engineers resident in Mexico, who recently organized ASME activities in Mexico City under group status, have held more than ten meetings, according to José M. Cabrera, secretary.

At its regular meeting Nov. 14, 1950, attended by 16 members and 18 guests, the Group heard T. Hall Barns, vice-president and plant manager, Reynolds International de Mexico, speak on the history and present status of aluminum as an industrial material.

Referring to the task ahead, Mr. Barns reported that the aluminum industry has been called upon by the U. S. Government to double its production in the next two years. This was a gigantic task, he said, because of the world-wide shortage of hydroelectric power. Fortunately, the aluminum industry has anticipated government demand and has been preparing for expansion. The industry has been supporting research and development which would assure achievement of the new production goal.

In October, 1950, the ASME Mexico Group took part in an interesting meeting as guests of the Mexico Ministry of Communications, Mr. Cabrera reported in a letter to Ernest Hartford, executive assistant secretary, ASME.

A Mexico group of the ASME was authorized by Council in November, 1949. Officers are: *Chairman*, George C. Siefert, manager, Mexico City Office, Combustion Engineering-Superheater Company; *vice-chairman*, Daniel M. Booth, regional manager, Export Division, Nordberg Manufacturing Company; *secretary*, José M. Cabrera, consulting engineer, Mexico City, Mex.; *treasurer*, Juan J. Martinez, chief, research and control department, Mexico Light and Power Company, Ltd.

In June 1950, the Mexico group asked for section status. Because the American Institute of Electrical Engineers and the American Society of Civil Engineers have established Mexico sections, mechanical engineers feel they are at a disadvantage without the prerogatives of full section status. ASME Council has the request under consideration pending clarification of policy on setting up of sections of the Founder Societies in non-U. S. territory.

ASME Calendar of Coming Events

April 2–5
ASME Spring Meeting, the Atlanta Biltmore, Atlanta, Ga.
(*Final date for submitting papers was Dec. 1, 1950*)

April 16–18
ASME, Region VIII, Annual Meeting, Hotel President, Kansas City, Mo.

April 17–19
ASME Process Industries Division Conference, Lord Baltimore Hotel, Baltimore, Md.
(*Final date for submitting papers was Dec. 1, 1950*)

June 11–15
ASME Semi-Annual Meeting, Hotel Royal York, Toronto, Ont., Can.
(*Final date for submitting papers was Feb. 1, 1951*)

June 22–23
ASME Applied Mechanics West Coast National Conference, Stanford University, Stanford, Calif.
(*Submit papers through J. N. Goodier, Division of Engineering Mechanics, Stanford University.*)

June 25–29
ASME Oil and Gas Power Division Conference, Baker Hotel, Dallas, Texas
(*Final date for submitting papers was Feb. 1, 1951*)

Sept. 10–14
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Houston, Texas
(*Final date for submitting papers—May 1, 1951*

Sept. 24–26
ASME Petroleum Mechanical Engineering Conference, Hotel Mayo, Tulsa, Okla.
(*Final date for submitting papers—May 1, 1951*)

Sept. 25–28
ASME Fall Meeting, Hotel Radisson, Minneapolis, Minn.
(*Final date for submitting papers—May 1, 1951*)

Oct. 11–12
ASME Fuels and AIME Coal Divisions Joint Conference, Hotel Roanoke, Roanoke, Va.
(*Final date for submitting papers—June 1, 1951*)

Nov. 25–30
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
(*Final date for submitting papers—July 1, 1951*)
(*For Meetings of Other Societies see page 173*)

1951 Regional Administrative Committee Meetings

Region	Place	Hotel	Days	Date (Tentative)
I	New Haven	Quinipiac Club or Taft	Fri–Sat	May 11–12
II	New York	Headquarters	Tues–Wed	March 27–28
III	Schenectady	Van Curler	Mon–Tues	May 7–8
IV	Atlanta	Biltmore	Sun	April 1st
V	Grand Rapids	Morton	Mon–Tues	April 9–10
VI	Omaha	Fontenelle	Fri–Sat	April 20–21
VII	Salt Lake City	Newhouse	Mon–Tues	April 23–24
VIII	Kansas City	President	Sun	April 15

ASME Standards Workshop

Gages and Gaging

The long-awaited revision of American Standard B1.2 on Screw Thread Gages and Gaging was recently released by Subcommittee No. 9 of the Sectional Committee on Standardization and Unification of Screw Threads and will be circulated for comment within ten weeks.

Bolts

Subcommittee No. 5 of Sectional Committee B18 on Dimensional Standardization of Bolts, Nuts, Screws, and Similar Fasteners, announced recently that its proposed revision of the American Standard on Round Unslotted-Head Bolts will be circulated for comment before March 1.

Surface Quality

Sectional Committee B46 on Classification and Designation of Surface Qualities held a meeting during the ASME 1950 Annual Meeting to receive the report of its subcommittee, which was established in 1949 to prepare a draft for a proposed American standard on physical specimens of surface roughness and lay. The Committee reviewed the draft and approved release of it for letter-ballot vote of the Committee.

Two types of physical specimens of surface roughness and lay were suggested by the subcommittee. The first type, the committee explained, was intended for precision reference of roughness height in checking calibration of instruments for measuring surface roughness, and not for visual or tactual comparisons. The second type, intended to illustrate commonly used machined surfaces embracing a range of roughness values and methods of manufacture, was to be used for determining roughness specifications and for control of surface roughness where visual and tactual comparisons were adequate.

E. J. Abbott, president and general manager, Physicists Research Company, Ann Arbor, Mich., is chairman of the Sectional Committee.

Drafting Practices

SECTIONAL Committee Z14 on Standards for Drawings and Drafting Room Practice which was reorganized in 1949 to revise and expand the 1946 American Standard for Drawings and Drafting Room Practice, met during the 1950 ASME Annual Meeting. The Committee has under way a standardization project which will culminate in about fifteen sections covering standardization of all aspects of engineering drawing and drafting practice to be known as the "American Drafting Standards Manual." The sections will cover such subjects as size and format of drawings, line conventions, projections, pictorial presentation, dimensioning and placing tolerances on drawings, castings, forgings, metal stampings, schematic and wiring diagrams, hydraulic diagrams, and others.

In addition to drafting information the new drafting standards manual will contain design information to assist draftsmen when called upon to make design decisions.

This project is being expedited by R. P. Hoelscher, chairman of the Sectional Committee, who is devoting a great deal of time to co-ordinating the work of the various subcommittees.

New Chairmen

R. G. Cummings, administrative engineer, Ford Motor Company, Dearborn, Mich., has been appointed chairman of Subcommittee 8 on Castings of Sectional Committee Z14.

A. E. Lofberg, advisory engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa., was appointed chairman of Subcommittee 15 on Schematic and Wiring Diagrams of Sectional Committee Z14.

Harry H. Gotberg, vice-president and chief engineer, Colonial Broach Company, Detroit Mich., was appointed chairman of Subcommittee 7 on Gears, Splines, and Serrations, of Sectional Committee Z14.

Kenneth Court, hydraulic circuit supervisor, Vickers Incorporated, Detroit, Mich., was appointed chairman of Subcommittee 17 on Hydraulic Diagrams of Sectional Committee Z14.

Abbreviations

A single sectional committee to be responsible for standardization of all abbreviations was recommended recently at a meeting of the Drawings and Symbols Correlating Committee of the American Standards Association. The proposal was made by a special committee which undertook to study the relationship of the work of Sectional Committee Z10, which is responsible for letter symbols and abbreviations for science and engineering, and Sectional Committee Z32, which concerns itself with standardization of graphical symbols and abbreviations for use on drawings.

To avoid overlapping responsibilities, the special committee recommended the following division of responsibility among Sectional Committees Z10, Z32, and the proposed sectional committee:

Z10 Letter Symbols. Standardization of letter symbols for equations and formulas under the sponsorship of The American Society of Mechanical Engineers.

Z32 Graphical Symbols and Designations. Standardization of graphical symbols for reference designations, and device-function designations under the sponsorship of the American Institute of Electrical Engineers and the ASME.

Proposed Sectional Committee, Abbreviations. Standardization of all abbreviations under sponsorship of the ASME.

Whom Do You Want for President in 1952?

THE National Nominating Committee is accepting proposals for nominations of members for the 1952 Presidency and other offices of the Society.

You as a member can help the Committee to find men of the caliber the Society needs to fill this and other high offices.

For instruction on how to submit proposals to the Committee see page 87 of the January issue.

Please send all proposals to Paul T. Onderdonk, Secretary, ASME National Nominating Committee, Consolidated Edision Company of New York, Inc , 4 Irving Place, New York 3, N Y.

Junior Forum

The Mechanical Engineer in Industry

AMERICAN industry is a specialized field which offers within its fences "high opportunities and honor" for all mechanical-engineering graduates who care to compete for them.

This point was made recently by J. E. Trainer, director and vice-president-in-charge-of-production, The Firestone Tire and Rubber Company, Akron, Ohio, in a talk to senior mechanical-engineering students of Pratt Institute, Brooklyn, N. Y. Out of his 36 years of industrial experience, first as an electrical engineer, then as a boiler manufacturer, and more recently as a director of one of the nation's large manufacturing organizations, Mr. Trainer made some basic observations on the nature of American industry and the truths that guide the destinies of men in it.

Excerpts from his talk follow:

Keep an Open Mind

The first thing that industry will expect of you is an open mind. Within recent years there have not been enough engineering graduates to fill the needs of industry. Now I can just imagine that each one of you is saying to yourself, "That's wonderful. I'm sure of picking off a nice fat job." Right up to this point I would say there is nothing abnormal nor unhealthy in this kind of reaction. I am, however, disturbed by the increasing numbers of engineering graduates who apply for jobs with a fixation—such as a fixed idea of specializing in design or a fixed idea of avoiding the drafting board. One of the first things industry will expect of you is an open mind.

The engineering graduates I particularly like. . . . are those who are willing to learn from the bottom up. I like a young engineer who is willing to get grease under his fingernails, or carbon black in his hair—who is willing to pitch in and work with his hands when the pressure's on to get the wheels turning again.

Of necessity, a mechanical-engineering course today can teach little more than fundamentals. Next, you will have to learn the application of those fundamentals to the specific problems, the specific equipment, the specific processes of the industry that provides you with a job. Don't be afraid of the menial tasks. Don't feel that any of them is below the dignity of an engineer. Your succeeding jobs will depend upon how well you do each present job; and how well you do it will be measured by more yardsticks than mere technical efficiency.

Nature of Production

Production is the creation of material things of value. It is these "things" or "products" available in quantity at reasonable prices that set our American standard of living apart from that of the rest of the world. It is the product, its quality and price, that vitally affects each one of us in our role as a consumer. It is the production end of our business that requires the specialized knowledge of a mechanical engineer. To be of most value . . . . a mechanical engineer must learn about production. He must learn prior and subsequent operations and their effect upon the operation of a piece of equipment under specific engineering review. In some instances, he must learn to know the physical limitations of operators of equipment

He must collaborate with chemists and physicists on equipment involving processes that may affect the physical characteristics or quality of a product. He must win the confidence of the foremen and supervisors who will have the responsibility for operating equipment which he may develop.

Your induction into business . . . . will probably be in a capacity that requires little more than your individual effort. Your progress . . . . will be influenced largely by your capacity to give leadership. Respect is the foundation of leadership—and the man who doesn't "know his stuff" from the ground up can never command the respect of those who work under his direction.

Leadership

But what is leadership? Like all intangibles, it is hard to define; but I have come to think of it simply as that quality in a man which makes other people want to help him.

A leader is a team man. He is willing to give more co-operation than he expects to get. He makes no promises he cannot keep. He doesn't try to hog the spotlight. He is not overjealous of his own authority. He is jealous of his own integrity. And he doesn't come to the work of a morning with a bellyache and a sour puss.

The Factory

A large factory is like a city. The engineer has to deal not only with machines and methods—he has to deal with people and participate in an organized endeavor. Bear this in mind: Companies are not brick and mortar and machines. Companies are people.

Doubtless you have heard stories about individual geniuses, mental giants who revolted at "regimentation," men who—because of sheer brain power—were provided with an ivory tower where they could work along as they pleased, without being disturbed and without disturbing others. There have been such men and they have made some worth-while contributions to society. Such men, however, left little beyond the discovery of a single principle or the invention of a single machine. Men whose shadows lengthen across our land today in the form of living organizations dwelt in no ivory towers.

Specialization

Specialization is a natural and necessary outgrowth of the widening of man's horizons to a degree that makes it impossible for a man to be a jack-of-all-trades. However, I would like to offer one word of caution: A specializing process sometimes tends to channel an individual's interests too narrowly. Strive to be a whole man!

The specialized field you're entering is broad enough to afford you high opportunities and honor within its own fences. The principles of leadership within that field are no different from those outside it. And if you later want to graze in broader pastures, you will not lack opportunity if you prepare yourselves for it.

Not one of you today knows your own latent capacities. You don't know where you can go. The qualities of leadership are developed through experience and mental exercise. Set a high goal! You may not reach it—but you'll enjoy the trying—and you'll come a lot closer to it for having tried.

Note to Student Members

AFTER you leave the campus you will receive MECHANICAL ENGINEERING only if you notify Headquarters of your new address. Send in both the old and new address. Best bet is to use the change-of-address forms obtainable from your honorary chairman.

Looking for a Better Job?

MANY fine executive and engineering jobs are available for which the Engineering Societies Personnel Service, Inc., is unable to recommend engineers. ESPS registration files are at an all-time low.

If you are unemployed or seeking a better job, contact the nearest office of the ESPS—New York, Chicago, Detroit, or San Francisco—and make your availability known.

ALFRED H. MEYER
Executive Director

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph Street

Detroit
100 Farnsworth Ave.

San Francisco
57 Post Street

MEN AVAILABLE[1]

ASSISTANT PRODUCTION-METHODS ENGINEER, 28, married. Four years co-ordination and expediting. Good methods and production man. Desires connection in New York area offering greater responsibilities. Evening student, 100 credits toward BSME. Me-803.

MECHANICAL-INDUSTRIAL ENGINEER, 30, BSE. 10 years' administrative and technical engineering functions in process and metal-fabricating industries. Development, co-ordination design, estimating, handbooks, specifications, reports, industrial and mechanical calculations, plant layout, tooling, and methods. Desires responsible engineering position. Me-804.

ENGINEER, MS, 13 years' ferrous and nonferrous production and research with plant and supervisory experience. Desires responsible position metallurgical field. Interested also in professorship of appropriate grade in recognized engineering college. Me-805.

CHIEF ENGINEER, 44, presently employed registered, mechanical, electrical, and administrative background in electric-utility and chemical plants. Experienced in heat-balance studies, auxiliary services, economic investigations and industrial-plant maintenance, reorganization, and job and cost control. Me-806.

MANUFACTURING ENGINEER, ME, Stevens 1937. Unusual precision metalworking background combining manufacturing engineering, methods, tooling, machine design, and time study. Currently employed as manufacturing project engineer. Me-807.

POSITIONS AVAILABLE[1]

STANDARDS ENGINEER, 30–45, engineering degree or equivalent, minimum of five years standards work, to take charge of standards department for eastern manufacturer of industrial machinery. Salary open. Y-4499.

INDUSTRIAL ENGINEER, one to five years' experience, preferably in the textile, carpet fabrication or needle trade. To $5000. Pa. Y-4650.

MECHANICAL ENGINEERS' conveying experience desirable, for manufacturers of conveyer equipment and components. One position is for the foreign department for work consisting of pre-

[1] All men listed hold some form of ASME membership.

(*ASME News continued on page 182*)

400° F.

350° F.

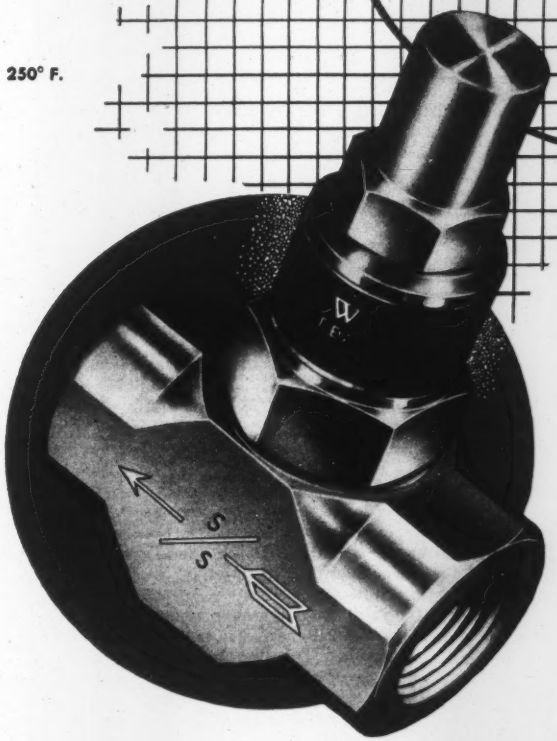
300° F.

250° F.

FOR EVEN TEMPERATURES

YARWAY

STEAM TRAPS



● Processes requiring careful temperature control call for Yarway Impulse Steam Traps on steam equipment.

The reason! . . Yarway traps maintain even temperatures because they *continually* sample and respond to a trickle of the condensate. There is no arrest in flow, no waiting for large quantities of condensate to accumulate, or trapped steam pockets to condense.

Other reasons why Yarway Impulse Traps have become first choice in many thousands of plants:

- They get equipment hotter, sooner
- Small size, light weight
- Easy to install, easy to maintain
- Only one moving part
- Good for all pressures
- Stainless steel construction
- Low cost

If you are not already familiar with these and other advantages of the Yarway Impulse Steam Trap, try one *for free* and find out for yourself. Call your nearby Yarway distributor, or write to:

YARNALL-WARING COMPANY

108 Mermaid Avenue • Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

Stainless Steel Body

YARWAY IMPULSE STEAM TRAP

paring quotations, estimating ocean freight and insurance expenses, and will involve financing. New York, N. Y. Y-4651.

ENGINEERS. (*a*) Mechanical or civil engineer, graduate, broad experience in design and preparation of plans and specifications for industrial facilities, utility systems, and airfields. Will assist in the supervision of architect-engineers' contracts for military construction and will involve review of plans for conformance with established design criteria and directives. Must be qualified to deal with representatives of military establishments and architect-engineer firms concerned with the various projects. $5400–$6400. (*b*) Architects, college graduates in architecture, capable of preparation of master plans for military installations. Should be a capable designer and have had a broad experience in preparation of layouts and the development of plans for large areas or municipalities. $4600–$5400. Washington, D. C. Y-4652.

ENGINEERING DRAFTSMAN, 25–35, mechanical graduate, at least three years' experience on piping and plant layout, to design and lay out oil terminal piping and equipment. $4200. New York, N. Y. Y-4654.

MECHANICAL ENGINEER, recent graduate, some experience desirable, and some agricultural background. To $5400. Hawaii. Y-4668.

ENGINEERS. (*a*) Industrial engineer, 35–45, graduate in industrial or mechanical engineering, or business administration, five to 10 years' experience, preferably in the installation of systems for staff of industrial-management organization. Considerable traveling. Headquarters, New York, N. Y. $8000–$10,000. (*b*) Methods engineer, for large manufacturer of machine tools and abrasives. New England. $12,000–$15,000. (*c*) Industrial engineer for staff of manufacturer engaged in paper conversion. Must have minimum of ten years' experience with this type of industry. $10,000. New York, N. Y. Y-4669.

TIME-STUDY ENGINEER, 35–45, mechanical or industrial graduate preferred, knowledge of blueprints and their specifications, drafting-board experience, understanding of machine-shop operations, experience in materials handling, conveyers, and process equipment helpful. Will supervise the department in carrying out responsibilities for determination of manufacturing methods, sequence of operations, and standard times; and the application of times to specific manufacturing orders for the purpose of rate setting, cost control, and sales estimating. $8000–$10,000. Midwest. Y-4673.

MACHINE DESIGNER minimum of five years' experience in design and layout of package line and automatic-packaging machine equipment. $7000–$9000. New York, N. Y. Y-4684.

PLANT SUPERINTENDENT, 40–50, engineering graduate preferred, or toolmaking background. Must be good administrator with knowledge of production methods, metalworking, finishing, and plastics. $7000–$9000. Conn. Y-4696.

MACHINE DESIGNER, at least ten years' experience on the design of portable equipment, incorporating pneumatics, hydraulics, and intricate motor-driven mechanisms, such as linkages, cam movements, toggles, leverages, etc., for developing pressures as high as 40,000 pounds. Engineering degree desirable, but not necessary. Minimum salary, $7200. Pa. Y-4697.

ASSISTANT CHIEF ENGINEER, mechanical graduate, some chemical plant experience. Should be good administrator with considerable knowledge of equipment, construction of buildings, and mechanical design for company in the chemical field. To $15,000. Mich. Y-4713.

VICE-PRESIDENT OF MANUFACTURING, 35–50, preferably mechanical graduate, for company manufacturing and selling heavy equipment to the mining, construction, petroleum, and marine industries and to municipal governments. Must be experienced in job-shop production, involving general machining and assembly of industrial equipment. Must be able to handle, through the plant works managers, the manufacturing operations, building facilities and equipment, production, employee relations, production control, cost control, etc. $15,000–$25,000, depending on qualifications, with substantial bonus. East. Y-4718.

ENGINEERS. (*a*) Chief design engineer with experience in the design of metal parts for ammunition and fuses. $10,000–$12,000. (*b*) Design engineers with experience in ordnance. Recent graduates willing to go on drafting board considered. $3100–$4600. Northern N. J. Y-4725.

ASSISTANT CHIEF ENGINEER, mechanical graduate, at least 10 years' experience with an electrical-equipment manufacturer, to assist chief engineer on product design, development and production of motors, generators, solenoids, controls, etc. Canada. Y-4731.

DESIGN ENGINEER, good background in pumps and compressors, preferably experienced in refrigeration and air conditioning. $7500–$10,000. Midwest. Y-4770.

MECHANICAL-ENGINEER DESIGNERS, 35–45, to take complete charge of the mechanical design of an architect-consultant specializing in hospitals, schools, apartment, and commercial buildings. Must have had extensive experience in plumbing, heating, and air conditioning. $7200–$9000. South. Y-4776.

MECHANICAL ENGINEER, graduate, for product-engineering department. Must have had experience with sheet-metal parts and metal stampings and experienced on business machines, typewriters, adding machines, or related products. $6500. N. J. Y-4792.

ENGINEERS. (*a*) Production engineer, 35–50, mechanical graduate, to organize and administer the methods, processing, tool design, toolmaking, and plant-layout sections. Must be capable of methods and processing work in connection with complex electromechanical instruments and supervising tool design and toolmaking facilities in connection with the above. $6500–$10,000, depending on experience. (*b*) Plant engineer, 35–50, mechanical or electrical graduate, to organize and administer the plant engineering department, including complete responsibility for plant construction and plant maintenance. Duties include installation, supervision, and maintenance of plant buildings; water-supply lines and systems, power-supply lines and systems; air, fuel and gas supply lines, etc. $6500–$9000. Brooklyn, N. Y. Y-4803.

CHIEF OPERATING ENGINEER, 40–50, 10 years' experience in responsible operating of gas plant, including metering. Knowledge of natural-gas distribution. Informed about utility rates. Will take complete charge of natural-gas operations for utility. $7500. Wis. R-7159.

FIELD ENGINEER, mechanical, or electrical with mechanical background, 30–35, well experienced in planning new plant installations or revising existing plant installation; prefer bakery, creamery plant, or allied industries experience; must be able to assume responsibility and deal with others. Will plan new equipment installations, carry out special assignments, deal with plant manager, plant engineers working from headquarters office for baking company. $6000–$7000. Considerable traveling. Headquarters, Chicago, Ill. R-7197.

DESIGN, DEVELOPMENT, APPLICATION, RESEARCH ENGINEERS, OR PHYSICISTS in the field of electronics, mechanics, or administration as encountered in complete guided-missiles operation. Will consider applicants from recent graduates to Ph.D. Clearance for work on classified projects required. To $12,000. Southwest U. S. R-7200.

CHIEF ENGINEER, 35–40, design-development engineer, mechanical, 10 years' experience in design and development manufacturing. Experience on heavy equipment, mining equipment preferred; knowledge of mechanisms, electrical control, and machinery applications desirable. Will be required to make field investigations; do some board work and engage in engineering-department activities for a manufacturer of mining equipment. Should have design ability, commercial slant, and potentialities for developing administrative ability. $6000–$7200. Ill. R-7260.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Feb. 25, 1951, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ABSHIRE, ROBERT W., Seattle, Wash.
ANDERSON, CHARLES E., San Francisco, Calif.
BARGER, J. P., Corning, N. Y.
BASTIAN, ROBERT J., Buffalo, N. Y.
BECKMANN, LEROY J., Toledo, Ohio
BELLAMY, B. C., Lamont, Wyo.
BLAYLOCK, RAWLAND E., Little Rock, Ark.
BOLT, JR., Ann Arbor, Mich.
BULLER, J. S., Manhattan Beach, Calif.
BURKE, THEODORE G., Ossining, N. Y.
CATENARO, EMIL A., Brooklyn, N. Y.
CHAPMAN, ALBERT, Garden City, Mich. (Rt & T)
DECROW, THOMAS W., Van Nuys, Calif.
DE LAUREAL, WILLIAM D., New Orleans, La.
DESAI, DHARMISINH D., Bombay, India
DOLLINGER, LEWIS L., JR., Rochester, N. Y.
DRESSEL, NOEL T., JR., New Orleans, La.
ELDER, ROBERT C., Atlanta, Ga.
FONG, AILEEN C. (Miss), Newark, N. J.
GEVE, DONALD W., Massapequa, L. I., N. Y.
GLICK, LAWRENCE V., JR., Edge Moor, Del.
GOLDBERGER, ROBERT S., Harrison, N. J.
GORKA, LEWIS R., Maplewood, N. J.
GUDAITIS, Peter P., New York, N. Y.
HALL, CARLISLE T., Charlotte, N. C.
HAUTH, HARRY H., Pittsburgh, Pa.
HEARTZ, R. S., Montreal, Que., Can.
HESS, ROBERT T., Cleveland, Ohio
HOWE, WILFRED H., Foxboro, Mass.
JACKSON, J. HARRY, Columbus, Ohio
KELLERSBERGER, ARMIN J., Montreal, Que., Can.
KORDYS, STANLEY, Newark, N. J.
KRAFT, DERALD H., Alliance, Ohio
LAING, G. F., Delavan, Wis.
LANN, LEONARD I., Irvington, N. J.
LAURIER, MAURICE J., New London, Conn.
MACWILLIAMS, WALLACE, JR., Baltimore, Md.
MAIORANA, SALVATORE J., Youngstown, Ohio
MAYBERRY, MYERS M., Pekin, Ill.
MCCLELLAND, W. B., Cleveland, Ohio
MCCLENATHAN, ROBERT C., Erie, Pa.
MCCULLOUGH, JAMES H., JR., Texas City, Texas
MCNAMARA, JOHN H., Moline, Ill.
MELMAN, SEYMOUR, New York, N. Y.
MILLIGAN, JOHN R., Evergreen Park, Ill.
MOORE, W. M., Shreveport, La.
MOREY, FRANCIS C., Kensington, Md.
MOSES, WARREN G., New Orleans, La. (Rt & T)
MULLER, LLOYD E., Flint, Mich.
PAULUCONIS, R. S., Greensburg, Ind.
PILLAI, V. S., Nagercoil, Madras, India
RICHBOURG, WALKER L., Greensboro, N. C.
RUNTON, LESLIE A., Lowell, Mass.
RUSSELL, ALFRED G., New Brunswick, N. J.
SAMPSON, RICHARD D., Cleveland, Ohio
SARKAR, S. K., Sindri, Bihar, India
SCHLUNDT, KENNETH C., Moline, Ill.
SCHNEIDER, ERNEST A., Toledo, Ohio
SCHOEPFLIN, HAROLD V., New York, N. Y.
SEIBOLD, FREDERICK L., Havertown, Pa.
SHEA, JOSEPH F., Plainfield, N. J.
SMITH, CHRISMAN O., Pittsburgh, Pa.
SODERBERG, C. RICHARD, JR., Lincoln, Neb.
STARKEY, WALTER L., Columbus, Ohio
SUNDE, GUNNAR, Brooklyn, N. Y.
TAYLOR, JAMES W., Ware Shoals, S. C.
THEILGAARD, RALPH E., Winfield, Ill.
TOZZINI, GENO J., New York, N. Y.
WEINMORELAND, JULIUS C., Washington, D. C.
YEH, GORDON CHIEN-KUAN, Cambridge, Mass.
ZAWISLAK, FRANK A., St. Albans, N. Y.

CHANGE IN GRADING

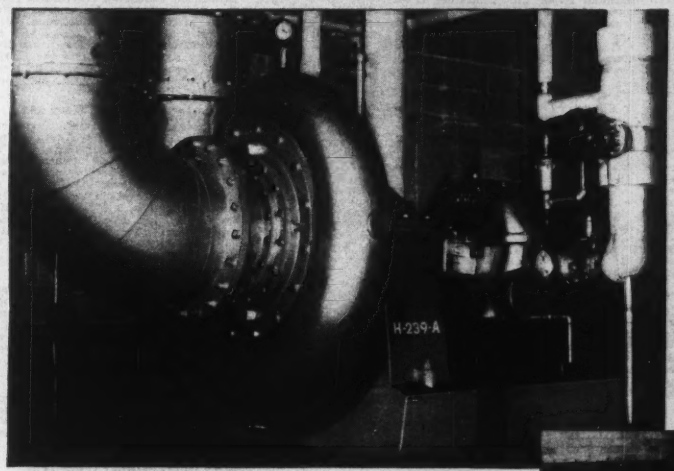
Transfers to Member and Associate

ADDY, JOHN L., JR., Grosse Pointe, Mich.
BARTON, RICHARD B., South Pasadena, Calif.
BOND, G. W., Colchester, Essex, England
BOUTELLE, ALBERT, Providence, R. I.
DEZUBAY, EGON A., Pittsburgh, Pa.
EVANSON, C. E., Chicago, Ill.
FLORIN, URBAN A., Chicago, Ill.
GILLIM, WILLIAM G., Tarrytown, N. Y.
HAMER, I. M., Ajax, Ont., Can.
HARTMAN, LAWRENCE R., Baltimore, Md.
HEATH, CHARLES O., JR., Corvallis, Ore.
KAHN, WALTER C., JR., New York, N. Y.
LYNN, E. W., New York, N. Y.
MACKAY, THOMAS R., Pomona, Calif.
PERRY, H. M., Portland, Ore.
RAO, K. SITHARAMA, Esplanade, Madras, India
RUTKOVSKY, HYMAN D., Dover, N. J.
SCHECK, FRED W., Chicago, Ill.
SEIFERT, ROBERT F., St. Louis, Mo.
SPITLER, THEODORE M., Schenectady, N. Y.
STRANGE, CHARLES A., Albuquerque, N. Mex.
SWARTHOUT, HARRY P., Schenectady, N. Y.
TANEY, AHMET R., Barberton, Ohio
VITI, JOHN, Philadelphia, Pa.
WEBER, MARION H., Cuyahoga Falls, Ohio
WILLIAMS, ERVIN M., Spartanburg, S. C.
WILLIAMS, GEORGE L., Los Alamos, N. Mex.
WILLIAMS, HARRY D., Yonkers, N. Y.
ZOLLER, LAWRENCE, Mexico, D. F.

Transfers from Student Member to Junior 100

(*ASME News continued on page 184*)

"always glad to see you... but we seldom need help!"



CENTRIFUGAL

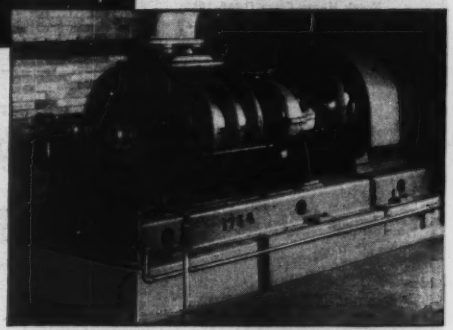
Type OIB Centrifugal Blower used for processing in a large eastern plant. Capacity 12,000 cfm. Similar R-C Blowers are utilized in other plants of this company.

The works manager of a large plant made this friendly statement to a Roots-Connersville representative. What he really meant was that R-C Blowers and related equipment perform so satisfactorily and dependably that they seldom need anything more than routine inspection by his own men.

In large and small plants, in every industry, R-C products uniformly give this kind of reliable operation. They continue to deliver rated capacities, year after year, with a minimum of maintenance—whether a small Rotary Positive Blower of 5 cfm capacity or a Centrifugal unit moving up to 100,000 cfm. And remember, only Roots-Connersville gives you this dual-choice.

If you are planning a new plant, expansion, or replacements, R-C engineers will work with you to select the equipment best fitted to your needs. Almost a century of experience is at your service.

ROOTS-CONNERSVILLE BLOWER CORPORATION
510 Michigan Avenue, Connersville, Indiana



ROTARY

One of two Type RCDH Rotary Positive units in vacuum service in a power plant. Capacities 3,380 cfm. and 3,490 cfm., respectively.

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

Obituaries

Herbert Watson Alden (1870–1950)

HERBERT W. ALDEN, director of engineering, Timken-Detroit Axle Co., died in Trenton, Mich., Nov. 11, 1950. Born, Lyndonville, Vt., Dec. 20, 1870. Parents, Horace Allen and Elizabeth (Eaton) Alden. Education, BSE, Massachusetts Institute of Technology, 1893. Married Madelaine Grier, 1893 (divorced); children, Horace A., Douglas G., Madelaine (Mrs. W. H.) Hynard. Awarded the Frank A. Scott Gold Medal, 1941; Distinguished Service Citation by Automobile Old Timers, 1946. He developed the first four-cycle vertical gasoline engine and designed the first magnetic chain drive. Held 76 patents in the field of motorcars. In World War I, studied tank warfare and designed the Mark VIII tank for the Army. He received the Distinguished Service Medal (U. S.) 1919. Fellow ASME, 1942. Past-president, SAE.

Ernest Wickham Ashenden (1870–1950)

ERNEST W. ASHENDEN, chief engineer, William Bros Boiler and Manufacturing Co., Minneapolis, Minn., died Aug. 31, 1950. Born, Minneapolis, Minn., Jan. 24, 1870. Parents, Albert and Agusta (Lane) Ashenden. Education, attended University of Minnesota; ICS. Married Tamar A. Millward, 1894; children, Alice A., Lucy R., Mabel M., Beth D. Mem. ASME, 1921. Served as chairman, Minnesota Section, ASME, 1925–1926.

Abraham Lincoln Burgan (1872–1950)

A. L. BURGAN, mill superintendent, Calumet and Hecla Consolidated Copper Co., Hubbell, Mich., died Oct. 25, 1950. Born, Lake Linden, Mich., July 13, 1872. Parents, Thomas and Elizabeth Burgan. Education, BSEE, University of Michigan, 1895; MS, 1896. Married Anna L. Read, Jun. ASME, 1897; Assoc. ASME, 1899; Mem. ASME, 1903. Survived by daughter, Ethel R. Hubbell, Mich., and son, George L., Laurium, Mich.

John Edward Cahill (1890–1950)

JOHN E. CAHILL, president, John E. Cahill Co., technical illustrators and architects, New York, N. Y., died Aug. 27, 1950. Born, New York, N. Y., Dec. 21, 1890. Parents, John E. and Julia M. (White) Cahill. Education, graduate, Morris High School. Married Gaynell Weber, 1910. Assoc. Mem. ASME, 1918; Mem. ASME, 1935. Survived by wife, and two children, Grace and Gaynell.

Frank Henry Clark (1865–1950)

FRANK H. CLARK, retired consulting engineer, who from 1919 to 1927 was technical adviser to the Chinese Ministry of Communication on railway matters, died Nov. 3, 1950, in New Orleans, La. Born, Pecatonia, Ill., July 23, 1865. Parents, Henry Stark and Harriet L. (Cable) Clark. Education, BS, University of Illinois, 1890. Awarded Gold Medal, Universal Exposition, St. Louis, Mo., 1904. Author of several technical papers. Mem. ASME, 1910. Served on ASME Boiler Code Committee and Locomotive Subcommittee. Survived by a son, Harold Ames, Miami Beach, Fla.; and a daughter, Mrs. Helen Louise (Paul L.) Hughes, Middletown, N. J., and six grandchildren.

Gilbert Collins Emmons (1888–1950)

GILBERT C. EMMONS, consulting engineer, Chicago, Ill., died in Oak Park, Ill., Sept. 4, 1950. Born, Jersey City, N. J., May 18, 1888. Parents, Francis S. and Annie F. (Titus) Emmons. Education, BSEE, Armour Institute of Technology, 1911. Married Alice Nall. Mem. ASME, 1942. Survived by wife and daughter, Alice Elaine.

Elbert Clement Fisher (1869–1950)

ELBERT C. FISHER, consulting engineer, International Paper Co., Container Division, Whippany, N. J., died Oct. 20, 1950. Born, Basking Ridge, N. J., April 21, 1869. Parents, Jonathan and Atheuis (Hegeman) Fisher. Education, attended Cooper Union. Married Sarah Randall Cameron, 1933. Mem. ASME, 1913. Survived by wife.

Burchard Fritz Heye (1901–1950)

BURCHARD F. HEYE, chemical and results engineer, Central Power and Light Co., Corpus Christi, Texas, died Nov. 5, 1950, at Victoria, Texas. Born, Lockhart, Texas, Aug. 11, 1901. Education, BSME, University of Texas, 1924. Married Mary Martens, 1924. Mem. ASME, 1946. Author of "Maintaining Clean Cooling Systems" and several technical papers. He was widely known for his pioneering methods in power-plant chemistry and boiler operation. Survived by wife, daughter, Mrs. F. C. Smyth, Colorado City, Texas; son, James, Victoria, Texas; and two grandchildren; his parents, Mr. and Mrs. H. F. Heye, Gonzales, Texas; and brother, Charles, San Antonio, Texas.

Glenn Alonzo Hollowell (1900–1950)

GLENN A. HOLLOWELL, production superintendent, West Texas Utilities Co., Abilene, Texas, died April 18, 1950. Born, Albany, Texas, June 7, 1900. Parents, Luther Severn and Bess (Reynolds) Hollowell. Education, BSEE, Texas A&M College, 1923. Married Emily De La Fosse, 1924. Mem. ASME, 1942. Survived by wife and two sons, Robert Glenn and William George.

William Reynolds Huttinger (1879–1950)

WILLIAM R. HUTTINGER, consulting engineer, Spring Garden Institute, Philadelphia, Pa., died Aug. 19, 1950. Born, Beverly, N. J., Aug. 18, 1879. Parents, John W. and Alice E. (Reynolds) Huttinger. Education, graduate, Cazinovia Seminary; The Franklin Institute; ICS. Married Mabel D. Conard, 1904. Jun. ASME, 1906. Survived by wife and three sons, C. Reynolds, William D., Richard C.

John William Layton (1908–1950)

J. WILLIAM LAYTON, mechanical engineer, Locomotive-Engineering Division, Fairbanks, Morse and Co., Beloit, Wis., died Oct. 26, 1950, at his home in Fairborn, Ohio. Born, Mad River Twp., Clark Co., Ohio, Jan. 9, 1908. Parents, Charles M. and Dora A. (Ady) Layton. Education, BEE, Ohio State University, 1933. Married Clara A. Deerhake, 1939. Jun. ASME, 1940. Survived by wife, two daughters, Mary Ann and Dorothy; and his parents.

Frank Thurman Leilich (1888–1950)

FRANK T. LEILICH, Col. U. S. A. (Ret.), consulting engineer, died in Baltimore, Md., Nov. 19, 1950. Born, Baltimore, Md., July 13, 1888. Parents, George Robert Lee and Lily (Kintz) Leilich. Education, Baltimore Polytechnic Institute, 1906; BSEE, Lehigh University, 1908; MSEE, 1909. Married Edith McManus, 1911; children, Robert T. (died 1932), George M. He was made Hon. Commander in the military division of the Most Excellent Order of the British Empire, 1948. Assoc-Mem. ASME, 1919; Mem. ASME, 1928. Survived by wife and son, George M., Jun. ASME.

Joseph Frederick Meade, Sr. (1892–1950)

JOSEPH F. MEADE, SR., Aviation pioneer, founder and president, Mercury Aircraft, Inc., Hammondsport, N. Y., died in Bath (N. Y.) Memorial Hospital, Nov. 7, 1950. Born, Buffalo, N. Y., Jan. 30, 1892. Parents, Joseph and Nettia A. (Maynard) Meade. Education, attended University of Michigan, 1913–1917. Married Ella M. Schultz, 1917. Mem. ASME, 1943. Survived by wife, son, Joseph, Jr., vice-president of Mercury Aircraft; and daughter, Jeannette E., a teacher at Saranac Lake (N. Y.) High School.

Ralph Harvey Rawson (1883–1950)

RALPH H. RAWSON, whose death was recently reported to the Society, was a consulting timber engineer, Portland, Ore. Born, Faribault, Minn., May 16, 1883. Education, ME, University of Minnesota, 1907. Mem. ASME, 1945. He was author of several technical papers and held many U. S. Patents.

Benjamin Skidmore, Jr. (1864–1950)

BENJAMIN SKIDMORE, JR., founder and former president, Skidmore Corp., St. Joseph, Mich., died Nov. 17, 1950. Born, Milwaukee, Wis., May 27, 1864. Education, high-school graduate. Mem. ASME, 1924.

Charles Henry Woolley (1905–1950)

CHARLES H. WOOLLEY, assistant manager, proposition department, The Babcock & Wilcox Co., New York, N. Y., died Nov. 11, 1950, in his home at Cranford, N. J. Born, Alexandria, Ind., Dec. 15, 1905. Education, BSME, Purdue University, 1927. Mem. ASME, 1943. He was the inventor of many improvements in steam-generator construction and operation. Survived by wife, Margaret S. Woolley; daughter, Carol M., both of Cranford, N. J.; also by his parents, Mr. and Mrs. A. C. Woolley; two brothers, George and Arthur, and a sister, Mrs. Mary Wells, all of Alexandria, Ind.

ASME Master-File Information

(Not for use of student members)

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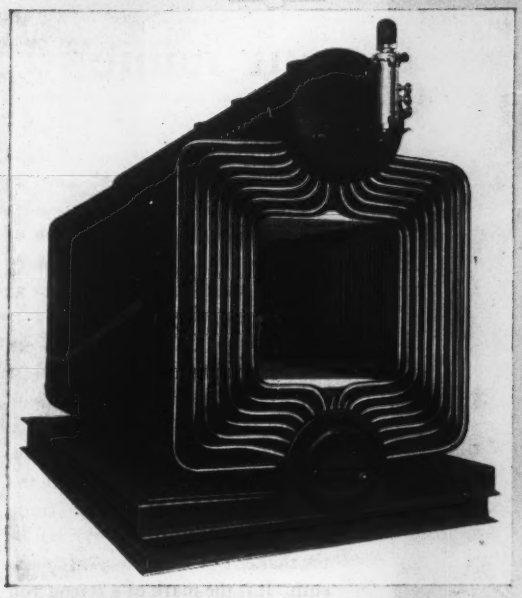
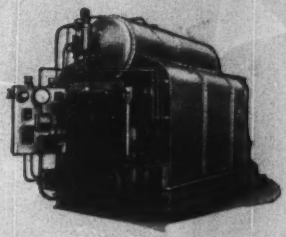
KEYSTONE STEAM GENERATOR

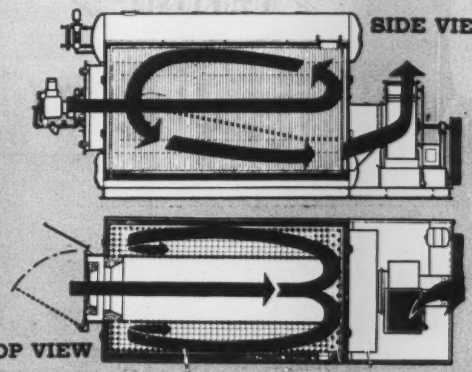
Offers

2-DRUM WATER TUBE DESIGN IN A COMPACT STEAM GENERATOR



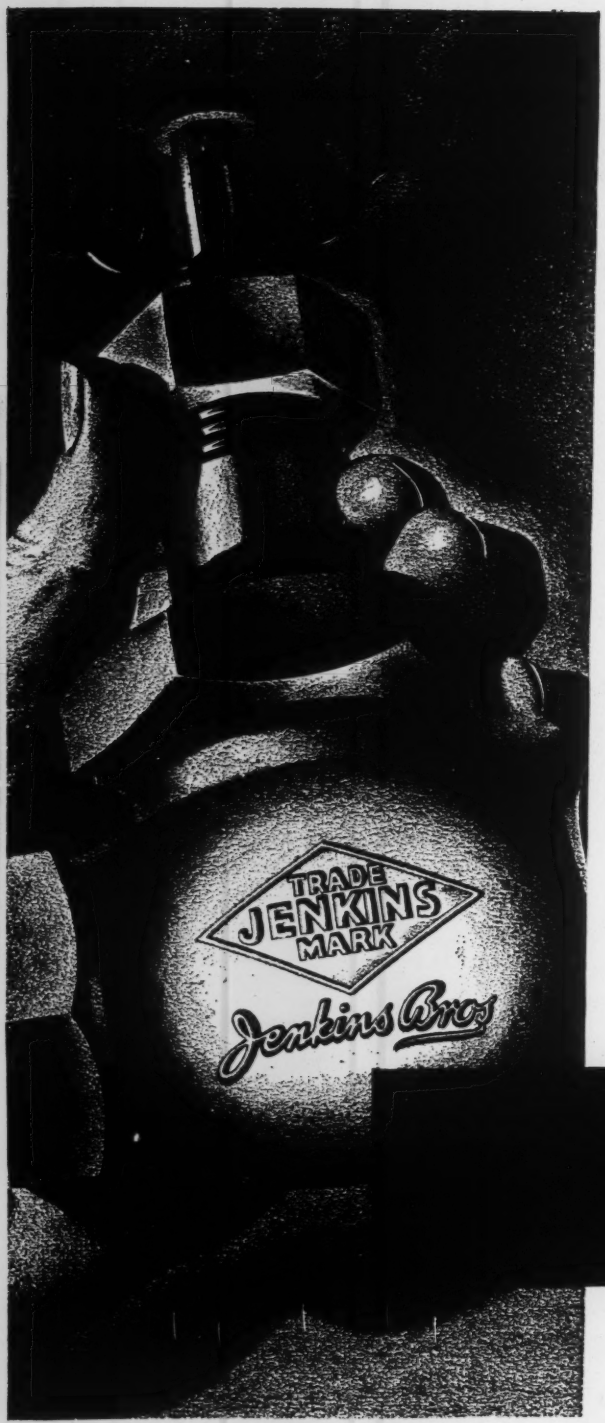


Here's big boiler performance in small cubage. Keystone combines in a factory assembled unit: low head 2-drum water tube boiler complete with boiler trim, a heavily insulated steel casing — automatic burner for gas, oil or both interchangeably — induced draft equipment and instrument panel with all controls mounted. Complete range of sizes from 75 to 800 hp. at pressures from 160 p.s.i. Write for Bulletin SB-38.



Hot gases contact solid side banks of water tubes in first pass to the rear of the Keystone, divide to left and right and are deflected upwards and over inclined baffles in both side water tube elements, again contacting bare metal heating surfaces — make return or third pass under these baffles, contacting bare metal again in the return trip to the rear and out of the boiler. Quiet induced draft fan provides all the draft required for top ratings. Spent gases need only be vented. No stack is required.

ERIE CITY IRON WORKS *1422 East Ave.* **ERIE, PA.**



"We will sign it with our name"

Few things in life are as precious to a man as his name. He bestows it with pride on his heirs. He does not sign it lightly. To the man of integrity, his signature is not so much a means of identification as an evidence of good faith.

When the Jenkins brothers were satisfied they had made the best valve money could buy, they *signed* it with their name. Today, as for over three quarters of a century, that signature — forming, with the famous Diamond, the Jenkins trade mark — is more than a symbol of the maker's pride in his craftsmanship. It is the mark of a friend you can trust.

Jenkins Bros., 100 Park Avenue, New York 17. Jenkins Bros., Ltd., Montreal.

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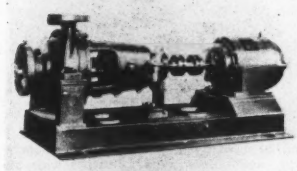
Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

• NEW EQUIPMENT

New Economy Process Pumps

An improved line of pumps for process use has just been announced by Economy Pumps, Inc., Division of Hamilton-Thomas Corp., Hamilton, Ohio. Known as "Type Q" pumps, the new line is especially designed for use with "Dowtherm" hot oil, condensate, propane, butane, gasoline, chemical and process liquors at temperatures up to 800° F.



Although materials used in their construction varies for each particular application, "Type Q" pumps have common design features said to contribute greatly to trouble-free performance and maximum reliability. Among these features are: vertically split casing with centerline support to maintain alignment at all temperatures; an extra deep, water jacketed stuffing box; a special sleeve construction which prevents leakage; and water-jacketed bearing housing for ring lubricated ball bearings, double row heavy duty radial bearings and two matched angular contact thrust bearings installed "back to back".

"Type Q" pumps are easily dismantled and re-assembled, without disturbing piping or alignment. They are designed for minimum NPSH requirements and are available with open, semi-open or enclosed impellors.

Twelve sizes are included in the new line, with capacities ranging from 10 to 1000 gallons per minute at heads up to 325 feet. Standard models include: bronze fitted, all iron, all bronze, steel, and stainless steel. Special materials can be furnished on order.

Further information can be obtained by writing the manufacturer: Economy Pumps, Inc., Hamilton-Thomas Corp., Hamilton, Ohio.

New Radiation Detector Announced By General Electric Co.

A new atomic radiation detector to permit direct radiation readings at a glance has been announced by General Electric's Special Products Division.

Called a "radiation monitor," the new instrument weighs less than a pound and is about the size of a quart oil can. It is equipped with a self-contained power source, and has neither tubes nor batteries.

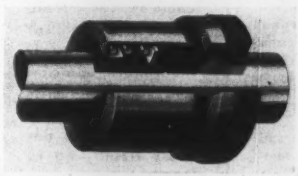
According to the engineers of the G-E General Engineering and Consulting Laboratory, who developed the device, radiation measurements are read from the monitor simply by noting the position of a pointer as it moves across a graded scale. The speed at which the pointer moves across the scale is in proportion to the strength of radiation, and the distance it moves in a given time indicates the amount of radiation to which the instrument has been exposed during that time.

The monitor is for use by engineers, scientists, doctors, and technicians who are working with or near sources of radiation, and can warn of the presence of radiation in amounts much less than those permitted by even the most stringent safety regulations, according to the engineers.

This sensitivity, coupled with a continuously-visible indication, will give warning of a radiation hazard in an area while there is still time to avoid excessive exposure. This differs from the type of monitor that is read only at intervals, when it may already be too late to prevent an overdosage, the engineers said.

Garlock Mechanical Seals For Rotary Shafts

Where leakless operation of a rotary shaft on a pump or other equipment is required, a good mechanical seal will do the job. The Garlock Packing Co., Palmyra, N. Y., offers a complete line of such rotary seals.



There is no wear on the shaft when a Garlock seal is used. Sealing is effected by leakless and positive contact between carefully lapped metal-to-carbon or metal-to-metal mating surfaces. One of these elements rotates with the shaft and the other is stationary. The stationary element does not contact the shaft.

These precision-built seals are made in several standard designs and in a wide range of highest grade materials. The selection of design and materials depends upon the service in which the seal is to be used. If none of the standard designs appears entirely suitable for any specific application, a modification of a standard design or a specially designed seal will be engineered and built for that job.

Thousands of Garlock Mechanical Seals have proved their effectiveness, durability and economy on shafts operating at high and low speeds and pressures. Users of Garlock seals are enjoying many months—or years—of trouble-free operation on equipment handling various liquids such as water, gasoline, beer, acids and paint.

Garlock Mechanical Seals are furnished for any kind of a rotary shaft application. Descriptive booklet on request.

Off Center Relief Valve Controls Saturated Steam

Due to an intensified and continuous research program, there has recently been developed an off center valve of the disc type which simplifies the control of 15 psig saturated steam with a low pressure drop. The valve illustrated, No. 780, is eight inches in diameter and has 150-pound American Standard raised face flanges. A double crank arm with adjustable weights facilitates accurate setting. The cylinder is not an actuator but simply a dash pot. On the left can be seen a 2 inch flanged outlet for overload relief.

These disc-type valves are available in smaller and larger sizes and for higher pressures. They are also used in air, gas, liquid and semi-solid service for the control and shut off of volume and pressure.

Manufactured by R-S Products Corp., 4600 Germantown Avenue, Philadelphia 44, Pa.

Kodak Offers Lens Converters

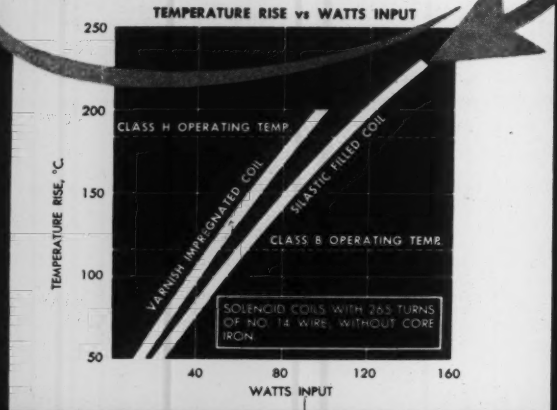
Two new lens attachments which shorten the effective focal length of several Kodak Cine Lenses have just been announced by the Eastman Kodak Co.

The first, known as the Kodak Ektar Converter, reduces the focal length of the Kodak Cine Ektor Lens, 25mm, f/1.4, to 15mm. The second, called the Kodak Vuedar Converter, reduces the focal length of the Kodak Cine Ektanon Lenses, 13mm. f/2.7, and 13mm. f/1.9, to 9mm.

The converters, in both cases, are precise optical accessories which screw into the front of the lens mount. In the case of the Kodak Cine Ektar Lens, the 25mm f/1.4 then becomes a fast wide-angle lens which covers a field approximately 50 per cent larger than than the 25mm. lens. In the case of the 13mm. Kodak Cine Ektanon Lenses used on the Cine-Kodak Reliant Camera, the reduc-

Continued on Page 42

SILASTIC* the resilient dielectric, stable from -60° to +200°C.



dissipates heat much faster than conventional insulating materials

Here's an insulating material that gives you all of the advantages of a rubberlike dielectric *at Class H temperatures*, plus extreme low temperature flexibility, plus about twice the thermal conductivity of conventional resinous or rubbery dielectrics! In a solenoid coil, for example (see graph above), Silastic gives 15% more capacity than resinous silicone insulation at 180°C. That's due to increased thermal conductivity alone.

Thermal stability plus high heat conductivity permit the Silastic coil to operate at 166% of the maximum capacity for an identical organic resin impregnated solenoid. Performance of over 1600 Silastic insulated main and interpole field coils in diesel-electric traction motors is further proof of the extraordinary advantages of Silastic as a dielectric.

In coils of all kinds, Silastic provides resiliency and relatively constant dielectric properties of temperatures ranging from below −60° to above 200°C., maximum resistance to corona, to electrical and mechanical fatigue and to abrasion, oil and outdoor weathering.

Silastic insulated solenoid has 166% of the capacity of identical Class B coil plus maximum shock, abrasion and vibration resistance over a span of 260 Centrigrade degrees from −60 to +200°C.

SEND TODAY! **For data on the properties, performance and applications for Silastic.**

(T. M. Reg. U. S. Pat. Off.)

from +500°F. *SILASTIC* stays Elastic to −100°F.

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tion of the effective focal length to 9mm. considerably increases the angle of view.

The Kodak Ektar Converter, 25mm. to 15mm., will list for $80 including Federal Tax. The Kodak Vuedar Converter, 13mm. to 9mm., will list for $32.50 including Federal Tax.

New 1½-Ton, Battery-Powered Trammer for Mine-Haulage Work Announced by G.E.

A new 1½-ton battery-powered trammer for use in mine-haulage work has been developed by the Locomotive and Car Equipment Divisions of the General Electric Co. Small and compact, but powerful, the trammer is designed for use in metal mines where clearances are restricted.

Available in any track gage between 18 and 24 inches, the new unit is 71½ inches long over bumpers, 35⁹/₁₆ inches wide and weighs 3000 pounds with its battery. With a standard battery, the trammer is 38⅛ inches high; with a high type battery, 44⅛ inches high. Individual drive from the motor to each of two axles provides maximum tractive effort.

Rated drawbar pull of the trammer is 400 pounds, but a maximum drawbar pull on level tangent track of 750 pounds is available. Maximum speed of the locomotive alone is seven miles per hour. Its speed at rated drawbar pull is three miles per hour. Tractive effort is furnished by a totally-enclosed four-pole d-c motor designed especially for battery-powered operation.

The gearing is double reduction comprising a spiral bevel and spur gear, producing a total gear ratio of 13.35:1. Anti-friction bearings are used throughout the entire drive unit.

A master controller, with one handle, governs both power application and braking operations. In acceleration, the controller provides three resistance steps and one step without resistance. The controller permits a limited amount of mechanical braking against the first two resistance steps to aid the operator in starting against a grade, or on slippery tracks.

Any standard make of storage battery may be used for power supply. A standard battery box is arranged so it can be lifted off or rolled off for battery transfer. The battery compartment is easily adapted to a high capacity battery.

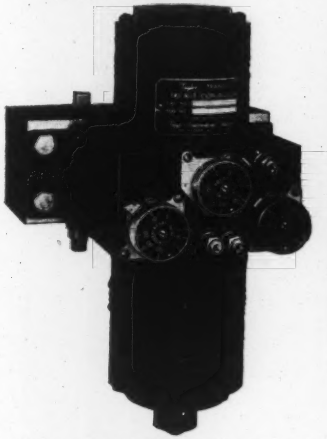
The locomotive has a folding cab which permits loading in limited mine hoist cages. The frame is of rigid, all-welded construction from rolled carbon steel plates. A turret mounted sealed beam headlight and a foot operated warning gong are supplied with the trammer.

• Keep Informed

Force-Balance Controller Incorporates New Control Circuit

The development of a force-balance, non-indicating controller—the "Transet" Tri-Act" Controller—for pneumatic transmission systems has been announced by the Taylor Instrument Companies.

Supplementing the recently announced "Transaire" Temperature and Pressure Transmitters and the Miniature "Transet" Recording Receivers, the new "Tri-Act" Controller completes the "Transet" Control System to give: 1) Faster, more accurate measurement of rapidly changing temperatures and pressures. 2) Closer process control with stability. 3) Continuous process records on a 30-day strip chart, together with all other features needed for efficient remote control—all in a 4³/₈" × 5" miniature pneumatic receiver.



This new "Tri-Act" Controller incorporates all the basic process control responses of conventional controllers but utilizes them in a different manner to give improved performance. The new circuit contains two closed loops in series—the first containing fixed proportional response and adjustable rate action; the second, with adjustable proportional response and adjustable automatic reset. Such an arrangement gives the controller the ability to apply corrective action to the valve soon enough to prevent process conditions from overshooting or undershooting the set point.

The new circuit in the "Transet Tri-Act" Controller permits four times faster reset rate and four times faster rate action (Pre-Act) than conventional instruments. The composite effect of the three responses allows start-up and pneumatic setting with no overpeaking. The faster response settings allow the use of rate and reset response, with stability, on processes where these effects were needed but could not be used.

Other features incorporated into this new controller are: the high capacity relay air valve which permits faster output action in response to process changes and makes it possible to capitalize on the use of faster measuring systems; self-sealing manifold to make piping and maintenance really simple; wide range of control response adjustments, conveniently positioned and clearly marked, make this controller simple to operate; a new, non-rotating type needle valve used on the adjustment dials assure duplication of re-

Continued on Page 44

This Lubricant saved us $2,098.16"

"During the seven month period before using LUBRIPLATE No. 130AA in the bearings of our Kraft Mill Lime Kiln, we used a conventional oil of the density recommended. The cost of the lubricant for the period was $2,134.00. In the seven months that followed, we only used 128 lbs. of LUBRIPLATE No. 130AA for initial filling and replacement at the cost of $35.84. LUBRIPLATE No. 130AA only requires weekly applications whereas the former lubricant required daily application."

• • •

The Brown Company is a progressive organization that is continuously seeking ways to improve their products, their methods and to cut costs. Naturally, when they found LUBRIPLATE No. 130AA, a grease type lubricant with great adhesive qualities, high film strength, and with high heat resistance, they saw the possibility of using it to their advantage in the bearings of their kilns and other equipment.

LUBRIPLATE Lubricants are available from the lightest fluids to the heaviest density greases. They reduce friction, wear and power consumption, they prevent rust and corrosion, they last much longer than ordinary lubricants. There is a LUBRIPLATE Lubricant that is best for every lubrication requirement. Let us send you information about the use of LUBRIPLATE Lubricants in your industry. *Write today.*

LUBRIPLATE DIVISION—Fiske Brothers Refining Company, Newark 5, N. J., Toledo 5, Ohio.

DEALERS EVERYWHERE—CONSULT YOUR CLASSIFIED TELEPHONE BOOK

LUBRIPLATE ***THE MODERN LUBRICANT***

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There is No Substitute for Experience CHIKSAN

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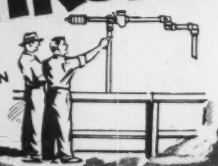

APPLICATION

Only with CHIKSAN Ball-Bearing Swivel Joints* can you benefit from a quarter-century of *specialized experience* in the development, design, manufacture and application of Swivel Joints for all purposes. CHIKSAN'S resources, facilities and personnel are *concentrated exclusively* on the production of Swivel Joints and their application to all kinds of installations. This is your assurance of efficient performance, long life and low-cost maintenance. There is no substitute for CHIKSAN!

CHIKSAN Engineers will gladly cooperate with you in selecting the correct Types and Styles of Swivel Joints for your particular requirements...and in specifying the proper Packing Unit for the fluid you handle. This valuable, experienced counsel costs you nothing.

*For full 360° rotation in 1, 2 and 3 planes. Unlimited flexibility in pipe lines can be secured simply by arranging swivels in proper sequence.

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Representatives in Principal Cities

Sold by Leading Supply Stores Everywhere

CHIKSAN TRADE MARK REG.

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

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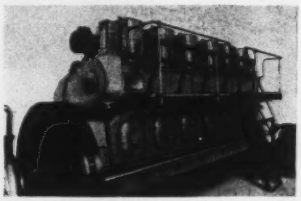
sponse settings with a high order of accuracy; built-in orifice cleaners and air strainers permits on-the-job servicing and gives added protection to the instrument; convenient alignment adjustments made with a screwdriver, makes it possible to instantly align the instrument for correct controller action.

The Tri-Act Controller can be either locally or panel mounted and is for use on temperature, pressure, flow or liquid level applications. For further details write for Bulletin 98097, Taylor Instrument Companies, Rochester 1, New York.

New Baldwin Diesel Engine

A new series of diesel engines, ranging in capacity from 700 to 2080 b.hp., is announced by The Baldwin Locomotive Works, Philadelphia 42. Designated as the series 700, these engines are four-cycle, 17-in. bore, 20-in. stroke, with speeds of 257 to 375 rpm. They are available with 6 and 8 cylinders, normally aspirated or supercharged.

The engine is intended primarily for stationary service such as electric power generator drive, pumping service on oil or gas pipe lines, municipal water pumping service, and other stationary power services. However, it is also well suited for diesel-electric main propulsion drive and direct reversing propulsion drive in marine service.



The new engine was designed to replace the Baldwin Model VM and VG engines, and to increase the power range while at the same time reducing the size and weight per horsepower. Welded construction of bedplate, frame and cylinder housing is a leading factor in this modernization program.

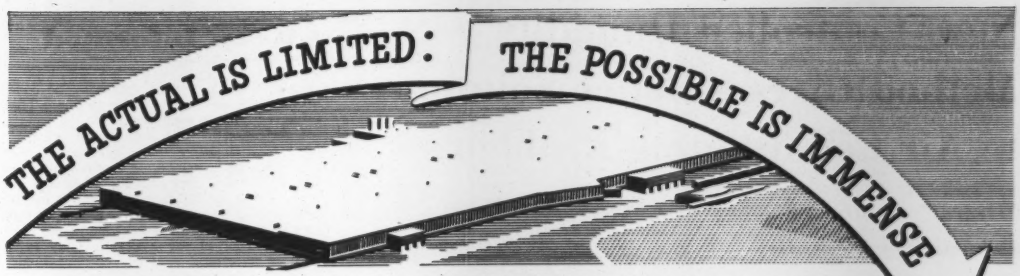
Another feature of the new design is the use of double wall cylinder liners with individual water jackets, thus eliminating internal water seals. Uniform liner temperatures are effected by the high velocity of the cooling water through the liner jackets. The jacket is designed to carry cooling water above the top piston ring to obtain maximum cooling efficiency. Four accessible water jumpers conduct the water from each cylinder liner to each cylinder head.

The crankshaft is a steel forging supported in precision-type bearing shells and bearings that may be removed for inspection through frame openings without disturbing the crankshaft. Complete inclosure of moving parts provides easy access to all engine parts.

The combustion chamber is of the open type, thus giving exceptionally smooth operation and fuel consumption. Cylinder heads are individual castings having two exhaust valves, two air intake valves, and fuel injectors in the center. Valve mechanism is inclosed by aluminum covers.

Individual fuel injection pumps serve each cylinder, with spring-loaded multihole type injectors. Fuel is supplied to injection pumps under pressure from a small gear-type pump at the free end of the engine.

Exhaust and air intake headers are of welded construction and are so arranged that



NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

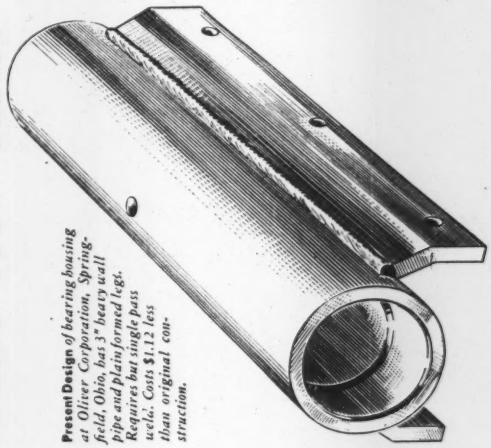
© LE Co. 1951

MANUFACTURER CUTS TOOLING COST $800.00

BY simple redesign to welded steel, substantial savings are being effected in the production of these bearing housings. At the same time, product strength and rigidity have been increased to assure maximum serviceability . . . long-lived operation. An initial saving of $800.00 on setup and tooling expense results from the elimination of drill jigs and boring fixtures as well as for patterns and core boxes required with the original construction.

Component parts are now preformed prior to welded assembly in a plain, low-cost, clamp type fixture. The tubing itself is bored as a simple lathe operation and the legs prepunched and bent as shown.

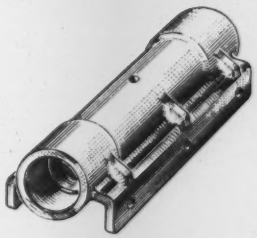
The resulting simplified production now possible with the welded steel construction is increasing the rate of output . . . reducing unit cost $1.12 per piece.



Present Design *of bearing housing at Oliver Corporation, Springfield, Ohio, has 3" heavy wall pipe and plain formed legs. Requires but single pass weld. Costs $1.12 less than original construction.*

How To DESIGN FOR WELDED STEEL is presented in the new 9th Edition "Procedure Handbook of Arc Welding Design and Practice." Contains latest data on machine design together with cost figures. Price only $2.00 postpaid in U.S.A.; $2.50 elsewhere.

the ACTUAL



Original Cast Construction *of bearing housing required fixtures for extensive boring and drilling operations.*

increasing the YIELD

First Changeover *to welded steel design has 90° formed legs welded to thin wall tubing. Was welded top and bottom as shown.*

the IMMENSITY of the POSSIBLE

A saving in cost of 24%

SEE HOW WELDED STEEL DESIGN SIMPLIFIES PRODUCTION

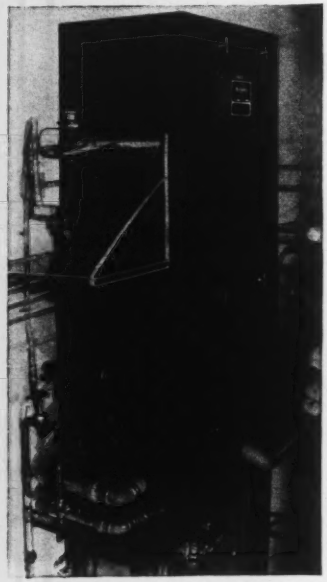
Machine Design Sheets free on request to designers and engineers. Write on your letterhead to Dept. 401,

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 1, OHIO

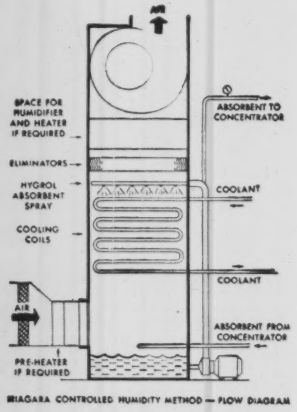
New "Controlled Humidity" Method Gives a Better Solution to Air Conditioning Problems

"Hygrol" Absorbent Liquid Dehumidifies Fresh Air Without Refrigeration



NIAGARA Air Conditioners or Dehumidifiers using "Hygrol" liquid absorbent give precise control of air temperature and humidity... at lower operating cost, with large savings in space and with smaller and less expensive equipment, in many applications.

This method dehumidifies the air by passing it through a chamber in which "Hygrol" spray removes its moisture and produces a low dew point. The "Hygrol" solution resulting is continuously and automatically re-concentrated, providing always full capacity in air conditioning and assuring always a constant dehumidifying capacity and a trustworthy, constant condition for your material, apparatus, process or room to be conditioned.



NIAGARA CONTROLLED HUMIDITY METHOD — FLOW DIAGRAM

"Hygrol" is a liquid, not a salt solution; it stays pure and non-corrosive; it does not cause maintenance or operating troubles in food plants or in chemical processes.

Investigate this new Niagara Method for "comfort" air conditioning as well as to protect quality in hygroscopic material, or processes or instruments, or to prevent condensation damage to metals, parts or products.

Write for Bulletin 112

NIAGARA BLOWER COMPANY

Over 35 Years Service in Industrial Air Engineering

Dept. ME, 405 Lexington Ave. New York 17, N. Y.

Experienced District Engineers in all Principal Cities

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exhaust and air intake pipes may be connected at either end of the engine. The exhaust header is water jacketed.

Lubrication is provided under pressure by a positive displacement gear pump, the oil supply being contained in the bedplate. Lubricating oil for priming is circulated by a motor-driven pump. The engine is arranged for air starting, using cam-operated air starting check values on each cylinder.

A governor of the hydraulic relay type and an overpseed stop of centrifugal trip type are gear-driven from the camshaft.

More than two years of performance tests and field service show the new engine to be an efficient and economical addition to the Baldwin line.

SKF To Produce Bearings Under Two Trademarks

SKF Industries, Inc., announces that it is placing in production ball and roller bearings to be marketed in the United States and foreign countries under an additional trademark.

Richard H. DeMott, president, said the trademark, "Hess-Bright," is a name well known in American industry. The Hess-Bright Manufacturing Co. was one of the nation's earliest anti-friction bearing producers, becoming affiliated with SKF in 1916.

"The principal reason for adoption of this trademark is to clarify the nature of our export operations under the anti-trust laws," he said.

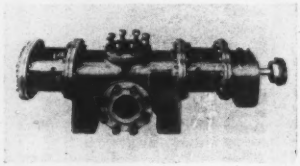
The use of another trademark, he explained, was made a provision of a consent judgment reached Sept. 29 between the company and the government.

DeMott said the company will continue to manufacture and sell to the domestic trade ball and roller bearings under the SKF trademark it has used for many years.

The first bearings having the Hess-Bright trademark are expected to become available early in 1951.

New Sier-Bath "Bracket Type" Screw Pump

A new external gear and bearing bracket type screw pump for positive displacement of non-lubricating liquids of all viscosities at 1 to 700 GPM, is announced by the Sier-Bath Gear & Pump Co., Inc., 9252 Hudson Blvd., North Bergen, N. J. According to the manufacturer, the new pump's single-point alignment, "dual-controlled" rotors, and other new features provide greater durability, easier installation, and faster servicing.



New Single-point Alignment—the external timing gears and all bearings are in housings, which form an integral unit with the pump body. Thus there can be no strain on bearings, or misalignment of shafts or rotors due to change of respective positions of pump body and separate housings. The timing gears and bearings move *with* the pump body, if there is a slight displacement of the pump elements during installation, or if the pump body expands when handling hot materials.

New "Dual-controlled" Rotors—for less wear on bearings and timing gears, rotors are

BIBLIOGRAPHY ON PLASTICITY

FOR THOSE who are or will be delving into this field of Engineering Mechanics, this Bibliography on Plasticity will prove a valuable and an essential part of their reference equipment because—

- ***It brings together*** practically all available references on the theory of plasticity, particularly of metals, and on its application to engineering problems.
- ***The Compilation*** is the result of an exhaustive search of magazines, books, technical indexes, abstracting and reviewing publications published in this country and abroad from 1835 to 1949.
- ***Within its 192 pages*** are 1845 items chronologically arranged, a subject index containing over 500 listings, and an author index with more than 1100 names.

Published January, 1951

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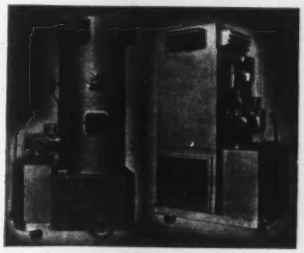
positioned axially as well as radially. Axial control is provided by new thrust bearings—in the form of double-row angular contact ball bearings—at the outboard end. These thrust bearings reduce sliding wear on the timing gears, and reduce friction by making possible the elimination of spacing washers between pump body and brackets. Radial control is provided by precision cut timing gears, and newly added heavy duty roller bearings.

New Ease of Maintenance—servicing is speeded by the new one-point alignment feature, and by the new bracket arrangement, which allows faster assembly. Trial and error methods are unnecessary as all parts are automatically positioned by shoulders and locknuts.

The new pump can be direct-connected up to 1800 RPM. It is available in horizontal or vertical construction, in corrosion resistant alloys, and with steam jacketed bodies and special stuffing boxes and bearings for high temperature applications. Hopper type bodies are available for extremely high viscosities.

Portable Space Heating Unit

For heating on construction jobs, quarries and a host of other temporary applications, the portable "Thermoblocs" shown in the illustration provide a complete heating unit, including fuel tank, mounted on easy operating trucks.



Information supplied by Prat-Daniel Corp. of East Port Chester, Conn., shows this equipment to be far more efficient and less space consuming than salamanders or other conventional methods in use. In addition, the heater may be effortlessly moved about, until the exact spot, providing the most effective diffusion is found.

Unit on the left provides 300,000 b.t.u. output, while that on the right is supplied in 100,000 and 200,000 b.t.u.'s.

Prat-Daniel also manufactures the Model 1,000 providing an output of 1,000,000 b.t.u.'s for applications requiring a large heat output from one source.

Information and a technical bulletin giving heat losses of various building materials and construction design and many other helpful tables is available by writing to the Thermobloc Division of the Prat-Daniel Corp. of East Port Chester, Conn.

Brazilian Sugar Mill First to be Entirely Powered by Turbines Geared to Rolls

Worthington Pump & Machinery Corp. is furnishing seven steam turbines with reduction gears for the first sugar mill ever to be driven entirely by steam turbines directly geared to the rolls.

The mill is being designed and built by Fulton Iron Works Company of St. Louis,

Continued on Page 48

TIPS ON MACHINING Stainless Steel for Higher Production AT LOWER COST

DATA!

Page B-3

AUSTENITIC STAINLESS STEELS (Cont.)

Wide Variance in Machinability

- Types such as 303 are considered free-machining 18-8 grades, while various other 18-8 grades such as types 321 and 347 are extremely difficult to machine. These latter types are especially serviceable at elevated temperatures and will be found to be used frequently for aircraft parts, particularly jet engine parts where extremely high heat may be encountered, and high strength is essential.

Cutting Fluids for Austenitic Stainless Steels

- For the machining of all grades of stainless steel the presence of active or effective sulphur in the cutting fluid in varying amounts is vitally important as this quality tends to reduce the work-hardening characteristics and tendency of these materials to pick-up and weld to tool surfaces.
- It should be pointed out that the severity of the machine operation has a direct bearing on cutting fluid application. Operations such as tapping, threading and broaching where slower speeds and heavier cuts are usually in evidence, require a cutting fluid high in active sulphur and factors of lubricity.
- Generally speaking, however, the free-machining grades of austenitic stainless steel demand a balanced amount of active sulphur while types such as 347 require the maximum possible amount to prevent chip weld and provide smooth finishes.

PROOF!

STUART'S ThredKut 99 FOR STAINLESS

- A Wisconsin manufacturer recently tried twelve different heavy duty cutting fluids for the tapping of type 310 stainless steel. One of the oils that failed sold for 45c per pound. Production with the best of these products amounted to 50 holes per tap. With Stuart's THREDKUT 99, production was increased to 550 holes per tap.

D.A. Stuart Oil CO.

2741 S. Troy Street, Chicago 23, Illinois

Ledeen cylinders improve the job

CYLINDER GIVES FOOL-PROOF GATE VALVE OPERATION

By remote control this Ledeen Heavy Duty air cylinder operates a 3" diam. stainless steel oil refinery gate valve. Corrosive fluids are being carried at a line pressure of 50 P.S.I.

The cylinder is 6" diam. x 4" stroke and opens or closes the valve, operating at 50 P.S.I. air pressure. In the event of power failure, a spring enclosed in the tube attached to the cylinder closes the valve automatically.

Standard Ledeen cylinders and mounting attachments are available from distributors' stock in major cities. Special cylinders on order.

Write for New Bulletin 500.

There are Ledeen *Medium Duty, Heavy Duty* and *Super Duty* cylinders for air, oil or water operation ready to help you, wherever you have to push or pull • lift or lower • press or squeeze • tilt or turn • open or close

Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders • Ledeen Cylinders are Good Cylinders •

Ledeen Mfg. Co.
1600 San Pedro
Los Angeles 15, Calif.

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Missouri and will be installed in the sugar mill of Refinadora Paulista, near Sao Paulo, Brazil.

The crusher and the six 35" x 78" mills will each be driven by an independent 400 HP Worthington steam turbine. Steam pressure will be 150 pounds with 150°F. superheat. At a later time pressure will be increased to 250 pounds. The exhaust steam at 15 pounds pressure will be used in heaters and evaporators. This exhaust steam will contain no oil, so the evaporators will stay clean and are expected to give better sustained performance than evaporators using exhaust steam from recriprocating engines, which generally contain some cyclinder oil.

A centralized control system is provided, the control panel being located on the operating platform. One man can adjust the speed of each turbine to best suit requirements. He can stop and restart any or all the turbines without the help of an engineer. A master-stop button is provided to stop quickly *all* turbines in case of emergency. Additional master-stop buttons may be located at selected points about the mill if desired.

The turbines are provided with adequate reserve power to start the mill easily when it is full of bagasse. This reserve power also permits the mill to operate at full capacity at times when steam pressure is lower than normal.

Turbine blading and the governor valve parts are of stainless steel which resists the action of either wet or superheated steam. Shafts are covered with stainless steel under the gland rings.

Turbine and gears are automatically lubricated and require no hand oiling. Maintenance is expected to be very small because of the very rugged design, the free use of superior materials such as stainless steel, the automatic lubrication, and the entire absence of reciprocating motion and pulsating torque.

The advantages of steam turbine power are well known but it has usually been applied to sugar mills through generators and motors. Worthington has pioneered in the direct of turbine power to the several sections of sugar mills without the interposition of generators or motors. Some drives have been in successful operation for a number of years. Through field experience and engineering research Worthington Turbine Drives have been developed to fully to meet the severe requirements of Sugar Mill Drive. The controls now available are valuable for saving labor and increasing output.

It is believed that the new mill of Refinadora Paulista, with its efficient and convenient all-turbine drive marks the beginning of a new trend in sugar mill drives.

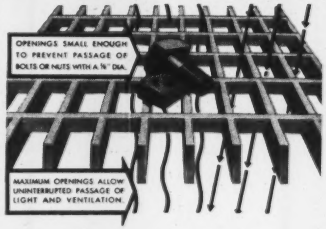
"Di-Acro" Vari-O-Speed Powershear

The "Di-Acro" Vari-O-Speed Powershear offers an entirely new theory in the high speed production shearing field as its design and rugged construction provide full capacity continuous shearing within its entire speed range of 30 R.P.M. to 200 R.P.M.

The cutting cycle of this Precision Shear can be quickly adjusted to the very fastest speed at which the operator can feed the material for any given shearing operation, thereby providing maximum operator productivity as the necessity of engaging the clutch for each cutting stroke has been entirely eliminated.

Speed of the shearing stroke for both continuous and single cycle operation is positively controlled with the speed control handle conveniently located at the operator's left.

TRI-LOK RECTANGULAR OPEN STEEL FLOORING


OPENINGS SMALL ENOUGH TO PREVENT PASSAGE OF BOLTS OR NUTS WITH A ½" DIA.
MAXIMUM OPENINGS ALLOW UNINTERRUPTED PASSAGE OF LIGHT AND VENTILATION

Tri-Lok strength is obtained by truss action through twisted cross-bar, curved in opposite directions at each bearing-bar. Standard openings in Tri-Lok Rectangular Steel Flooring are 1" x 3⅞"—other sizes can be supplied as required.

Diagonal, or Super-Safety U-type Flooring, and stair treads of all types, are available. Bulletin NB 1140 describes the construction features of Tri-Lok Open Steel Flooring.

The Tri-Lok Company is also equipped to furnish *riveted* and Tri-Forged *welded* open steel flooring. Tri-Lok grating can be furnished in a variety of metals, including aluminum alloy, stainless steel, etc.

DRAVO CORPORATION
National Distributor for the
Tri-Lok Company
Dravo Bldg., Pittsburgh 22, Pa.
Sales Representatives in
Principal Cities

DRAVO

SINCE 1902
IRVING GRATINGS
ALL TYPES

Best Workmanship and Service
AT COMPETITIVE PRICES

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Home Office and Plant: 5010 27th Street
LONG ISLAND CITY 1, NEW YORK
Western Division: 1810 Tenth Street
OAKLAND 20, CALIFORNIA

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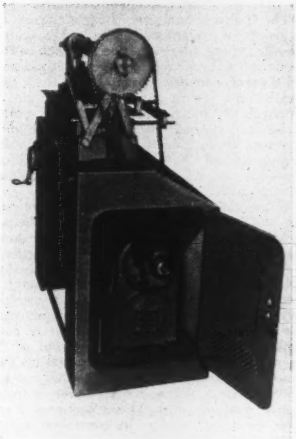
A non-repeating positive safety clutch, which allows "single stroke" operation with the shear blade moving at any desired speed within the entire range of the unit, is also incorporated in this precision machine.

The extremely slow shearing speeds possible with the "Di-Acro" Vari-O-Speed Powershear provide a sensitive and smooth shearing action for shearing many delicate and unusual types of materials which do not react favorably to the "impact" type of shearing.



The cutting range of the "Di-Acro" Vari-O-Speed Powershear extends from the lightest of materials in plastics, fibre, mica, leather and rubber to heavy gauges of aluminum, cobalt steel, chrome molybdenum, leaded brass, stainless steel and many spring tempered materials. In all these materials, a clean cut free from rough edges or burr is assured because of the sustained accuracy built into this sturdy precision machine.

Every metal working plant will find the "Di-Acro" Vari-O-Speed Powershear a valuable addition to its equipment, regardless of the larger capacity shears now being used, because of its compact size and the greater speed and accuracy possible in production shearing of the smaller parts and pieces with this extremely flexible precision machine.

This precision unit is also an excellent machine for specialized shearing applications in many industries outside of the metal working field and its ease of operation makes it especially adaptable for women operators.

Both the design and operating convenience of the "Di-Acro" Vari-O-Speed Powershear is enhanced by a substantial knee hole in the front of the cabinet which provides comfort for the operator and allows close observation of the work.

Write to O'Neil-Irwin Mfg. Co., 308 Eighth Ave., Lake City, Minn.

Ohio Boxboard Uses G-E Equipment In Plant Modernization Plans

The Ohio Boxboard Company, Rittman, Ohio, has installed modern electronic equipment which will enable its machines to increase the production of high quality paper and will cut down on machine repair time.

The new equipment includes a General Electric multiple generator sectional drive with electronic-amplidyne regulators which

Continued on Page 50

What they say!

"We use your Helicoid Gages in very severe pulsation work and have found them very satisfactory."

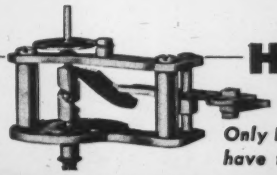
"A Helicoid Gage operating under the worst conditions for 4,000 hours is still functioning, although other gages have been worn out."

". . . no other gage has come close to giving such long life and accuracy as the Helicoid."

"Your Helicoid Gages have been used in our plant for more than five years and have proved their superiority over competitive makes."

"We have six gas engines equipped with Helicoid Gages on the oiling system, subject to more vibration than any rack and pinion gage will stand."

All quotes are taken from letters in our files. Write today for HELICOID GAGE catalog.



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Only Helicoid Pressure Gages have the Helicoid Movement

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AMERICAN CHAIN & CABLE COMPANY, INC.
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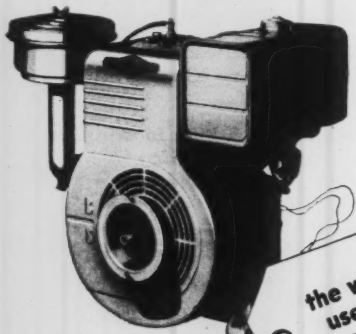
More than 5,000,000

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

The performance record of more than five million Briggs & Stratton single-cylinder, 4-cycle, air-cooled engines speaks for itself.

BRIGGS & STRATTON CORP., Milwaukee 1, Wis., U.S.A.



"Preferred Power" for home, farm and industrial equipment — powered by gasoline engines.

the world's most widely used single-cylinder gasoline engines

World Wide FACTORY SUPERVISED SERVICE

In the automotive field Briggs & Stratton is the recognized leader and world's largest producer of locks, keys and related equipment.

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will operate a 128-in. paperboard machine at a top speed of 550 ft. per minute, an increase of 60 per cent over its former speed, according to company engineers.

Accurate tension control for the high speed machines is provided by G-E paper tensiometers, a new development, first installed at this mill. These keep a continuous check on the tension of the paper being produced by the machines. Installed at the driers and calenders, the tensiometers regulate the tension to a closer degree than is possible by human judgment control.

The G-E sectional drive system consists of a group of seventeen individual machine drives, the engineers explained. Each of the sections—wet end and first press, second and third press, nine drier sections, and three calender and a reel or cutter sections . . . . . is mechanically independent of all other units. A web of folding grade boxboard is the only physical connection between sections, the engineers said, but electrical co-ordination provides a closely integrated machine throughout.

Each section includes one main drive motor and in some instances additional helper drives. These are controlled from a completely isolated adjustable-voltage generator, and are held in precise and accurate speed relationship with each other through a master brain consisting of an electronic-amplidyne regulating system. With one master rheostat, this system is capable of controlling the whole machine—a total of 32 drive motors ranging from 5 to 100 hp and amounting to more than 750 hp of adjustable speed drive. When required for maintenance, washing, or machine adjustment, however, each section may be controlled individually through all required operations from jogging to full run, it was said.

Because each section drive is supplied from its own generator, the drive is unaffected by disturbances accompanying starting and stopping of other sections or by load changes such as snap-offs. On the other hand, the engineers said, smooth adjustment of over-all speed can be accomplished while paper is on the machine.

The control panel for each section is enclosed in a separately packaged factory assembled unit. Because each section drive operates on generator-voltage control only, without change in the motor field excitation, maximum torque efficiency is assured. The drive speed is measured by a tachometer generator whose output voltage is compared against the over-all paper machine's constant reference voltage. To the extent that the tachometer generator voltage differs from the reference voltage, the electronic-amplifier responds almost instantly through an amplidyne exciter to change the generator voltage, restoring the desired drive speed.

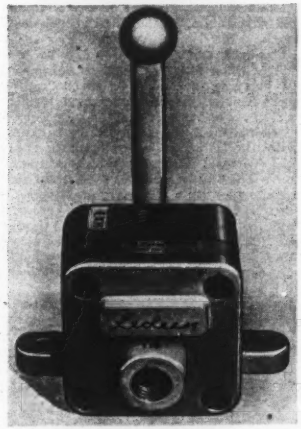
Ohio Boxboard manufactures a wide variety of paper products, including folding cartons, corrugated and solid fibre containers, and many converted specialties. Presently, the company produces in excess of a million pounds of paper fibre per day, a quantity which will be increased with the accelerated production brought about by the planned installation of similar drive equipment on two additional machines.

Air and Hydraulic Actuating Valves

A line of valves for actuating air or hydraulic cylinders has just been introduced by Ledeen Manufacturing Co., Los Angeles, California. The firm also builds a line of actuating cylinders for air, oil, water or steam operation.

The Ledeen Valves embody the rotating disc construction and are made in three

types: for hand-operation, foot-operation, and finger or solenoid operation. This group of valves is available in 14 different models for 5 different cycles in 6 sizes and may be used for controlling the flow of air, oil or water.



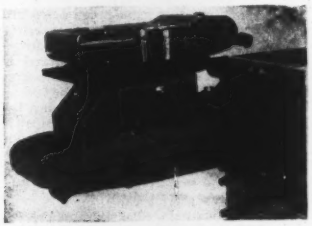
The Hand-operated Valves turn 45° each way from neutral, a total of 90°. The Foot-operated Valves turn 15° each way from neutral, or 30° total.

The Finger or Solenoid-operated Valves are actuated by two simple poppets, which are depressed upon $^1/_8$" by light finger touch. Only two small solenoids are required to actuate the poppets and require only momentary energizing.

Bulletin shows circuit diagrams and operation detail, dimensions and weights, and description of the 14 models available. Copies may be had by writing for Bulletin 510, Ledeen Manufacturing Co., 1602 So. San Pedro St., Los Angeles 15, California.

New Du Mont Finished-Print Recording Camera

A new oscillograph-record camera recently announced by the Instrument Division of Allen B. Du Mont Laboratories, Inc., Clifton, N. J., provides, in one minute, a complete record of an oscillograph image. No darkroom facilities are required. Waveform comparison is immediate. The camera is designed specifically for application with any standard, 5-inch, cathode-ray oscillograph.



The camera employs the Polaroid-Land process for delivering a finished print at the termination of each completed exposure or set of exposures. By means of a sliding mount, the camera may be positioned so that several traces can be recorded on a single print, for side-by-side comparisons. There is also a built-in detent which divides a single print into one, two, or three separate exposure areas. This feature facilitates economical use of the film.

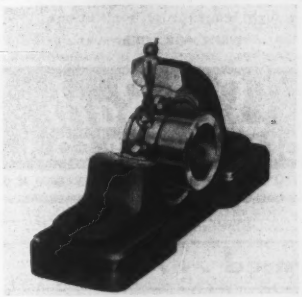
An illuminated data card provides an easy, positive method of photographically recording information on each print. Mechanical operation of the camera is simple and foolproof.

The lens aperture is f/2.8, and the lens is coated to minimize halation. Shutter settings are 1/100, 1/50, 1/25, Time, and Bulb. Size of print is $2^1/_4 \times 3^1/_4$ inches, with a ratio of dimensions from trace to recording of 2.25:1.

The camera is mounted to a standard 5-inch oscillograph by means of a clamping ring which clamps to the Du Mont Type 2501 Bezel.

New Ball Bearing Pillow Block

Boston Gear Works, Quincy, Mass., is presenting a new stock line of self-aligning, precision ball bearing pillow blocks and flanged cartridges in shaft diameters from $^1/_2$" to $1^1/_4$".



An exclusive feature of Boston Gear Pillow Blocks and Flanged Cartridges is a specially designed labyrinth seal, known as the "Safety-Vent-Seal", which automatically provides the correct amount of lubricant, excess grease being permitted to escape under pressure. The lubricant is sealed in and dirt and dust are sealed out. Seals cannot blow out.

The chrome alloy ball bearing used in these supports has a spherically ground outside diameter to permit the bearing to align itself in the rigid, one-piece, precision machined housing which is cast of Boston gear iron. This makes for accurate shaft alignment and quick mounting. The bearing is supported around its entire circumference, assuring a solid mounting in any position.

Boston Gear Pillow Blocks and Flanged Cartridges are carried in stock by the eighty authorized Boston Gear Works distributors throughout the United States and Canada. Complete dimensional information, load rating and list prices for all shaft diameters are given in Boston Gear Catalog No. 55, copy of which will be mailed on request. Write Boston Gear Works, 66 Hayward St., Quincy 71, Mass.

Savings at National Malleable Through G-E Electric Furnaces

The National Malleable & Steel Casting Co. of Cleveland, Ohio, large-scale manufacturers of malleable castings for the railroad and automotive industries, has achieved substantial savings through the use of General Electric annealing furnaces.

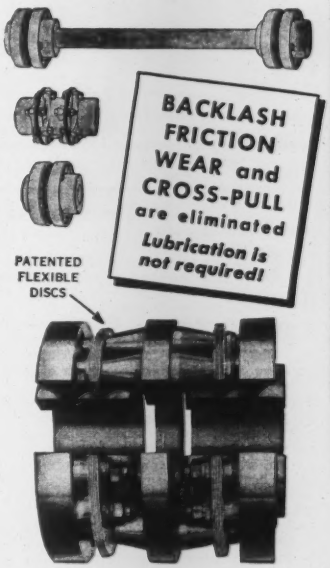
Continued on Page 52

THOMAS
Flexible ALL METAL
COUPLINGS
FOR POWER TRANSMISSION
REQUIRE NO MAINTENANCE

Patented Flexible Disc Rings of special steel transmit the power and provide for misalignment and end float.

Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
1 to 30,000 RPM

Specialists on Couplings for more than 30 years



THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT.
NO MAINTENANCE PROBLEMS.
ALL PARTS ARE SOLIDLY BOLTED TOGETHER.

Write for the latest reprint of our Engineering Catalog.

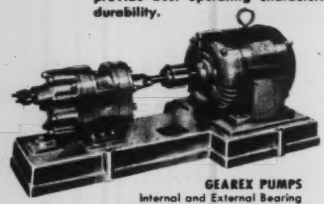
THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

Pumping Costs Go Down When Pump Quality Goes Up

Sier-Bath ROTARY PUMPS

The surest way to cut pumping costs is by specifying the best pumps you can find. Then—day after day—your power or process installation will run at top efficiency, with smallest chance of costly interruption, and lowest cost for pump maintenance and replacement.

★ **Point by point, Sier-Bath Rotary Pumps are designed and constructed to provide best operating characteristics, lowest maintenance, and greatest durability.**



GEAREX PUMPS
Internal and External Bearing Types. Capacities 1—550 GPM, Discharge 250 PSI for viscous liquids, 50 PSI for water.

SCREW PUMPS
Internal and External Bearing Types. Capacities 1—700 GPM, Discharge 1000 PSI for viscous liquids, 250 PSI for water.

★ **No Metallic Contact Between Rotors**—sustains high volumetric efficiency.

★ **Precision Cut Timing Gears**—maintain exact rotor clearance.

★ **High Volumetric Efficiency**—reduces wear caused by erosion.

★ **Low Pressure on Stuffing Boxes**—reduces leakage, adds to packing life.

★ **Long Life**—husky shafts, rotors—high load capacity bearings, deep stuffing boxes.

★ **Direct Connected Up to 1800 RPM.**

Available in corrosion resistant alloys, horizontal or vertical construction. Special bodies, stuffing boxes, bearings for high temperature applications.

WRITE FOR LITERATURE

Founded 1905 Members A.G.M.A.

Sier-Bath GEAR and PUMP CO., Inc.

9270 HUDSON BLVD., NORTH BERGEN, N. J.

• Keep Informed . . .

Five furnaces have been installed, three of which are high temperature annealing furnaces, rated at 390-kw. 460 volts, 3 phase, 60 cycle, maintaining a temperature of 1800 degrees F; and two are low temperature drawing furnaces, rated at 230-kw, 460 volts, 60 cycles, with a maximum operating temperature of 1300 degrees F. Each of these furnaces has a five-ton capacity load.

Each furnace is controlled by an electrical control system, designed for special application to the malleable casting industry, and may be shut off independently by a master switch, without affecting the other furnaces in the bank. Each furnace has separate controls that regulate and keep constant the heat on the side of the furnace. An identical control equally regulates roof heat so that uniform heat is assured throughout the furnace, and a high quality of annealing results.

In electrifying the operation of these furnaces, National Malleable has shortened the time cycle involved in producing castings. Two G-E electric cranes are combined to reduce the operation of either loading or unloading to single co-ordinated efforts. A gantry-type crane, operating on tracks running parallel to the bank of furnaces carries loads to each furnace. From this crane's control cab, the operator activates a crane hoist, situated above the furnaces to lift the furnace being loaded. Next, the load is moved forward underneath the furnace and set on supports. The furnace is then lowered to its base and, by means of a sand seal, forms an air-tight chamber, thereby providing an atmosphere control and contributing to the reduction of scale on a heated metal.

In addition to the reduced production time cycle and the higher quality resulting from this change to electric heat, National Malleable has realized other economies and advantages. The high expense involved in the use of annealing containers has been limited. Better working conditions and substantial savings in floor space have resulted. Replacement of heating units and other maintenance expenses has been reduced to an estimated 40 per cent below those of fuel-fired furnaces. Consequently, expansion plans at National Malleable and future developments in their production system, involve still further use of electric heat.

New "Pul-Pac" Model Announced by Clark

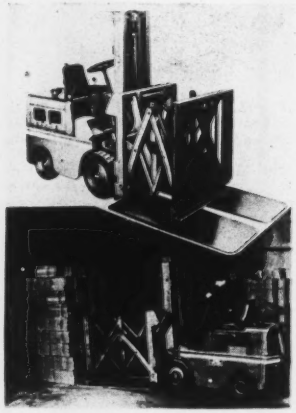
A redesigned "Pul-Pac", fork-truck device that handles unit loads without use of conventional pallets, will go into production during February, according to announcement by Clark Equipment Co. The new model is described as incorporating improvements developed as a result of users' experience.

Principal change from the early "Pul-Pac" design is the adoption of a pantograph-type linkage to actuate the gripper-jaw and pusher rack, in place of the long piston rods employed on previous models. The new construction allows a shorter hydraulic stroke from a more powerful piston, and eliminates the severe bending stresses to which the long pistons were subjected. Strong side forces formerly exerted on the long pistons are now absorbed by the pantograph, which is ruggedly built to withstand them. Also the new construction eliminates all "Pul-Pac" structure back of the uprights, which contributes to maximum visibility and safety for the driver.

The new "Pul-Pac" can operate in less space than former models. There are no restrictions on tilt of uprights. The unit has a detachable mounting, and is interchangeable with standard forks up to 54-inch usable length.

The rack and gripper-jaw can be lower slightly when fully extended to engage and grip carrying sheets flat on the floor. The mechanism is easily disassembled for service.

Originally introduced as an experimental model, the "Pul-Pac", was the sensation of the 1947 National Materials Handling Exposition. That first model was shortly redesigned, to include a number of improvements. The soundness of those first tow designs is attested by the fact that practically all the original machines are still in regular operation. But Clark engineers, say company officials, were never fully satisfied; and development work and exhaustive tests in actual use have gone on continuously to culminate in the redesigned model.



Full information concerning the Clark "Pul-Pac" is obtainable upon request to Clark Equipment Co., Industrial Truck Division, Battle Creek, Mich.

Alco Making General Patton Tanks

The American Locomotive Co. has established an entirely new organization at its Schenectady plant to handle ordnance production, while continuing intact its peacetime organization for the manufacture of diesel-electric locomotives, it was announced by Duncan W. Fraser, chairman and president of Alco.

Railroad customers were assured in a policy letter sent by Mr. Fraser that Alco-GE locomotives and parts would continue to be produced at capacity levels, and that commitments on deliveries would be met just as in the past, unless national conditions affecting all builders interfered.

Alco will build the newly-announced medium tank described by the Department of the Army as "an improved General Patton with greater firepower" in shops which formerly were used to produce steam locomotives. "Beginning with engineering, and through the purchase of raw materials, production and accounting, all ordnance manufacturing at the Schenectady plant will be handled by an

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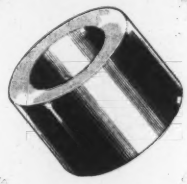
WORKS WHERE OTHERS WON'T



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entirely separate organization", Mr. Fraser said in his letter.

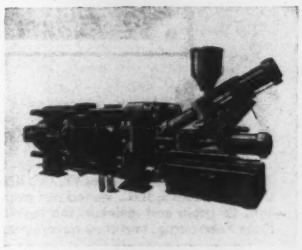
Railroad presidents and other executives receiving the special letter were reminded that the Defense Transport Authority of the Interstate Commerce Commission had requested a material program for new locomotives and maintenance from the National Production Administration. Mr. Fraser requested their "intense assistance" in this effort, pointing out that the ability of American railroads to handle tremendously increased traffic certainly is one of the most urgent requirements of the defense economy ahead.

A. M. Hamilton, vice president, who was in charge of the production of tanks at the Canadian Tank Arsenal operated by Alco's Canadian affiliate, Montreal Locomotive Works, during World War II, has been placed in charge of the newly-established Ordnance Division of the American Locomotive Company. Another vice president, W. E. Corrigan, has been appointed contracting officer of the Ordnance Division. Corrigan negotiated Alco's numerous contracts with the Government, amounting to more than a billion dollars, during World War II.

Alco ranked among the first fifty producers of war goods in the last war and was described by the Department of Defense in its announcement of the tank order as "one of the Army's principal producers of tanks in World War II." The new tank order to Alco, announced by the Army December 6th, is a $100,000,000 contract for production of 500 tanks and for establishment of new facilities for their production at the Schenectady plant.

300-Oz. Injection Molding Machines, Now Produced By Watson-Stillman

Watson-Stillman Company, Roselle, N. J., world's leading manufacturer of Plastics Molding Machinery, has just announced the completion of their latest contribution to the Plastics Industry—a gigantic 300-ounce capacity machine, largest Injection Molding Machine ever built.



Fully hydraulic, this machine is equipped with manual as well as automatic single cycle control and adjustable speed control of the injection ram. Individual adjustable control of injection and clamping pressures is also provided.

With a 300-ounce per shot capacity, a clamping pressure of 1,500 tons, and a platen area which will accommodate a 4 ft. × 6 ft. mold, this new W-S giant will produce injection moldings of a size and weight heretofore only dreamed about.

A study of the specifications immediately indicates the production possibilities of this new machine. Its immense capacity, clamping pressure, mold size accommodation, and its 4 ft. (maximum) stroke and 6 ft. daylight

Continued on Page 54

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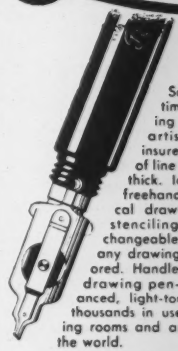

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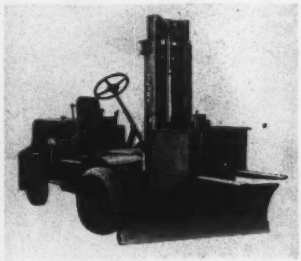
plow are placed to receive the standard forks of a lift-truck when attachment is desired. Two "T" bolts, which can be turned by hand, fasten the plow securely to the forks. Above the channels is a ballast box which may be filled in the event that the plow's weight of 400 pounds does not make sufficient contribution to traction requirements.



The plow is mounted to ride below the forks of the lift-truck. It is secured to the back plate of the attachment by an unique mounting which allows it to pivot in two directions, compensating for uneven running surfaces. It is held in operating position by spring tension, which allows it to pivot backward when obstructions are met. The 22½-inch blade may be set at an angle from the front of the truck in any one of six positions. It is designed with a curvature to prevent a vacuum behind to accumulate snow, and the blade shoe at the base is hardened steel to insure long wear under the most severe conditions.

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opening will now enable molders to produce parts with deeper draw. It opens up entirely new production and market possibilities. And, with machinery of this size, markets already invaded will be greatly expanded.

For example, one-piece injection molded inner-door liners are now made possible for the refrigeration industry as well as one-piece inner boxes. Washing machine agitators already produced of plastics will soon have a companion plastics piece—an entire tub—injection molded.

This new W-S 300 oz. Injection Molding Machine removes most of the present limits of thermo-plastics in television and radio housings, and thermoset now has a serious competitor in many of the larger applications for housing.

Two well known concerns are about to go into production with this new W-S equipment, Amos Molded Plastics, Div. of Amos Thompson Corp., Edinburg, Ind., and General American Transportation Corp., Chicago, Ill. This latter company also recently installed two similar 85 Ounce Machines which can be converted to 300 Ounce capacity.

Snow Removal Simplified By New Fork Truck Attachment

To meet industrial need for easy and economical removal of snow, a new snow plow has been designed for use with all Clark pneumatic-tired fork-lift trucks of more than 1,000-pound capacity, according to a report from the Industrial Truck Division of the Clark Equipment Co.

The attachment is readily detachable and no tools are required to mount, dismount it, or to adjust the blade. Two channels on the

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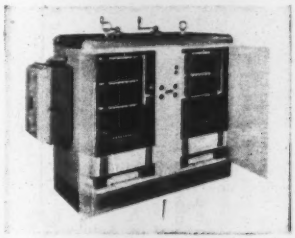
To operate the plow, the truck pushes against a vertical support plate and two pushing blocks which rest against the base of the upright assembly. Since the blade meets the greatest resistance to forward movement at the base, the pushing force is exerted at the lowest possible point and in a normal level plane. This attachment is available for Export sale. Additional information may be obtained from the Clark Equipment Co., Industrial Truck Division, Battle Creek, Mich.

New Dual 300/600 and 400/800 Ampere Selenium Rectifier DC Welders



New dual 300/600 and 400/800 ampere selenium rectifier dc welders are available from Westinghouse Electric Corp.

Each dual unit offers two welding circuits in one common enclosure. These circuits may be used independently, or in parallel to provide a single circuit of twice the capacity.

Parallel operation of the two units for maximum capacity is obtained by means of a bridle placed across the secondary output terminals. A clutch-and-sprocket and chain arrangement makes possible independent or unit operation of the current control handles on each individual welder.

A primary contractor is supplied to facilitate use of these machines on automatic and stud welding applications.

For further information write Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Makes Lube Plant From Surplus Units . . . Saves Millions

How surplus, unused units were converted into a modern solvent refining, lubricating oil plant at a saving in materials estimated in the millions is told in "Kelloggram" No. 4 (1950) just published by The M. W. Kellogg Co., refinery and chemical engineers of Jersey City, N. J.

The 1500-barrel-per-day plant, designed and constructed for the Phillips Oil Co. at Kansas City, Kansas, has completed its first year's run and is, Phillips says, considered the most modern in the world today.

Before Phillips and Kellogg went to work, back in 1948, the plant was a complete but surplus alkylation-isomerization unit replete with storage tanks and comprising 45 major vessels as well as concomitant heat exchangers, pumps, switch racks, furnaces, heaters and control rooms. Wherever possible this equipment was used in the conversion, according to Kellogg.

When the job was completed, Phillips had a lube plant comprising two-stage vacuum distillation, propane fractionating and deasphalting, phenol treating, propane dewaxing, clay treating and deodorizing. To this Phillips has added unique barrelhouse facilities of their own design for blending, packag-

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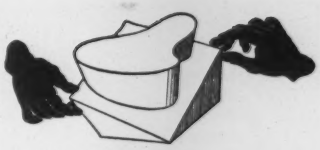

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How and in what shape a part is made is, we hold, of fundamentally greater importance than of what it is made.

In designing a piece of machinery it is necessary to consider Design, the choice of steel, and its Heat Treatment. All three are highly significant factors, but of them we believe Design to be vital because even the best in steel and treatment will not save a poorly designed part.

To evaluate the importance of good design and its vital relationship to the selection of steel and its heat treatment, we have prepared a book—"Three Keys to Satisfaction". This starts by discussing mainly design factors involved in stress concentrations, and includes useful sketches comparing poor and good features of design from the aspect of subsequent metallurgy. It is available on request to all engineers and designers.

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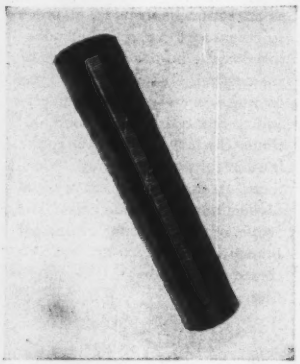
ing and otherwise preparing the final product for shipment.

According to Kellogg, the most complete picture of the conversion itself may be found by considering the phenol treating unit. Here, five towers in the former butane isomerization section were converted directly into the five main towers of the phenol unit. None were removed from their foundations. In some cases tray designs were changed, in others the bubble caps were altered, new nozzles added, old ones closed off.

Had Kellogg bought new, main towers for the phenol unit, the cost would have run in the neighborhood of $170,000 for the towers alone. Add to this the large savings in erection costs, foundations, steel work, heaters, mechanical equipment, heat exchangers, piping, building and instruments, and the total labor and material savings reaches a significant figure on just this one section of the completed plant, it is stated in the "Kellogg-gram."

New Type of Filtering Membrane



A new type of filtering membrane for its line of industrial filters has been developed by Titeflex, Inc., 500 Frelinghuysen Ave., Newark, N. J. Designated as the Titeflex "Well-Screen" membrane, the new product is normally constructed of 316 ELC stainless steel wire formed to a screen of cylindrical shape. Used within the filter itself, to support the filter cake which is the actual filtration medium, these cylinders speed up the filtration process. Because of the triangular cross-sectional shape of the individual wire which makes up the Well-Screen cylinder, clogging is eliminated. Another advantage is that in backwashing, the automatic process by which Titeflex filters are cleaned without manual labor, Well-Screen membranes achieve high efficiency because the back-wash flow reaches its highest velocity at the exact point of support of the filter cake. Well-Screen membranes, although developed specifically for use with Titeflex filters, can be utilized with various types of filtration equipment. They are available in various sizes, and can be provided in any alloy which can be drawn into wire. The manufacturer will furnish additional details upon request.

Allis-Chalmers Announces "Design Changes For Its Type SPW Transformer"

Design changes in its single and two-bushing potential transformer (Type SPW) which have reduced weights up to 60 percent in some ratings and have decreased dimensions by one-third are announced by Allis-

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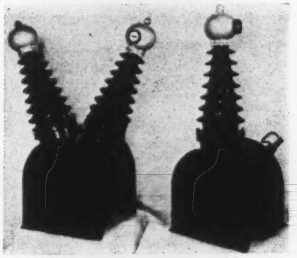
Chalmers Manufacturing Company, 949 S. 70th Street, Milwaukee, Wisconsin.

The redesigned transformer has a completely welded heavy gauge steel case. This results in a hermetically sealed unit free from breathing, which extends the life of the insulating oil by guarding it from oxidation.



The core of the transformer is made of high permeability cold rolled steel to provide a lighter and smaller unit with high accuracy. The electrical coils are protected by corona-free preformed angles, channels and barriers of insulating material to provide exceptionally high impulse strength. The complete assembly is thoroughly dried and liquid filled under vacuum. Large cooling ducts allow free oil circulation and high thermal rating.

These potential transformers are available in the 500-va, 60-cycle, oil-filled class in 24, 34.5, 46 and 69-kv ratings.

A New Torque Meter

An unusual combination of a 9-cylinder, 450-hp. radial aircraft engine (left) driving the supercharger section from an 18-cylinder radial aircraft engine (right) through a Torquemeter that gives a constant indication of horsepower output, is used in the aeronautical engineering laboratory of The University of Oklahoma, Norman, Okla.

Horsepower output is measured by a Baldwin SR-4 Torquemeter which absorbs no power. It is essentially a short length of shaft to which a group of special SR-4 resistance wire strain gages are bonded so as to form a Wheatstone bridge. The corners of the bridge are connected through slip rings on the shaft to stationary brushes in the case and thence to an indicator calibrated in inch pounds. Horsepower, a simple function of torque and shaft speed, is readily computed. The indicator, not shown, is a portable, battery-operated, null-balance instrument which may be placed at any convenient point near the torquemeter pick-up.

The engine-blower combination, in addition to engine performance calibration, is used as a compressor to supply air for a number of different graduate research proj-

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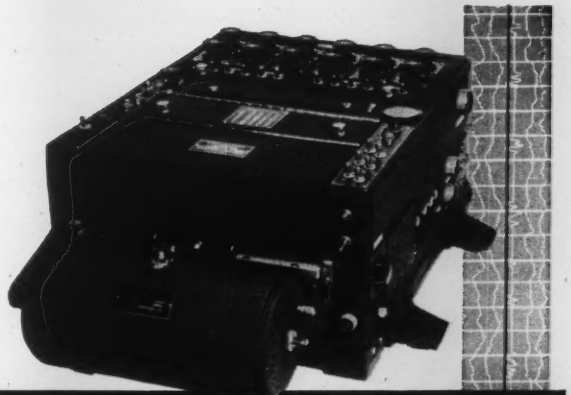

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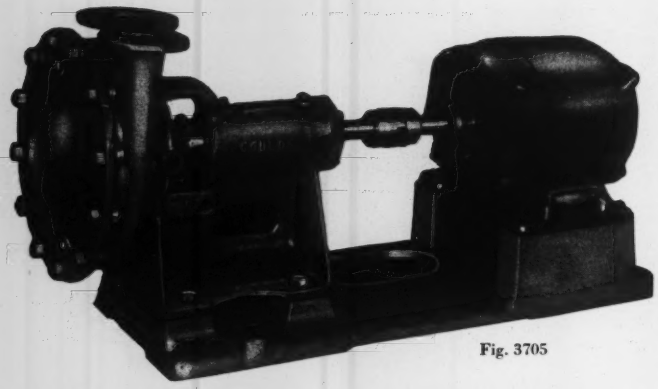

Fig. 3705

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The Goulds 3705 stainless line represents the last word in effective design. Fig. 3705 pumps will give you efficient, dependable, 24-hour service in handling corrosive liquids—at low cost.

CAPACITIES—

Goulds stainless steel centrifugals are made in 8 sizes with capacities to 750 G.P.M. and heads to 180 ft. depending upon capacity.

ADVANTAGES—

Exceptional efficiency (see Bulletin for performance curves) plus extreme simplicity make this an ideal pump for corrosive applications. High interchangeability of parts cuts stocking problem. Quick inspection or cleaning—simply remove casing cover without disturbing pipe connections.

Write for Bulletin 725.3 for complete details on this new stainless steel pump.

MEMBER HYDRAULIC INSTITUTE U.S.A.

Goulds PUMPS INC. Seneca Falls New York

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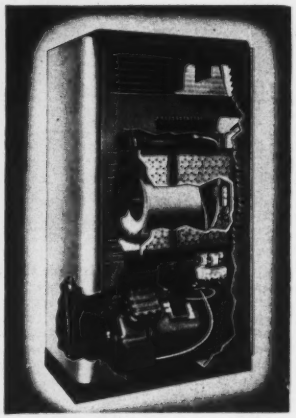
ects, including the air supply for a small high-speed air tunnel. The unit will also be used to supply air for testing ram-jet engines and will serve as an air supply for a gas turbine unit burner research project.

Westinghouse Offers Improved Self-Contained Air Conditioner



An improved self-contained Unitaire air conditioner is now available from Westinghouse Electric Corp. The Unitaire is designed specifically to provide resort weather in the summer in homes, factories, offices, and other commercial establishments by cooling, dehumidifying, circulating, and filtering the air. All-year-round air conditioning can be provided by addition of either steam or water-heating coils and an outside air duct connection for ventilation air supply.

The Unitaire is a factory-assembled packaged air conditioning unit that is complete in every detail: hermetically-sealed Freon-12 Compressor, water-cooled condenser, direct-expansion coil, and fan. It is easy to install, requiring only water, drain, and electrical connections to place it in service.

This air conditioner comes in three sizes; two, three, and five horsepower, with cooling capacities of 24,000, 36,000, and 60,000 Btu per hour respectively. It may be connected for single, two, or three phase operation on 50 or 60 cycle sources. Voltage ratings on the units range from 230 volts on single-phase to 550 volts on three-phase.

The cabinet is constructed of 18-gauge steel panels press-formed into an attractive design. Exterior is finished in semi-gloss, two-toned baked enamel. A welded steel frame supports all components of the air conditioner. The smallest unit covers a floor area 36 in. $\times$ 22 1/2 in. and is 68 3/4 in. high. The largest unit has a floor area 44 in. $\times$ 22 1/2 in. and is 77 1/16 in. high.

For further information write to Westinghouse Electric Corp., Sturtevant Div., 200 Readville Street, Hyde Park, Boston 36, Mass.

Worthington Announces New 105′ Portable Air Compressor

An improved 105′ portable air compressor has been announced by Worthington Pump & Machinery Corp.

The new compressor is lighter, lower and more maneuverable. It is built around the standard Worthington Blue Brute compressor and is powered by either Diesel or gasoline engine.

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New features and advantages claimed by the manufacturer include: a new zero pressure retractable third wheel; new underslung spring mounted undercarriage with heavy duty commercial 15″ trailer tires;

a simple, retractable support leg; a new style unit core radiator with pressure cap to prevent boiling and better operation of engine at higher temperatures and altitudes; a new carburetor with fixed jets for better economy; and relocation of instrument panel and battery box to give unrestricted full length tool boxes.

The redesigned 105′ Worthington Blue Brute compressor is 10″ shorter, 4″ lower and weighs 300 pounds less than previous models. For further information please write Construction Equipment Div., Worthington Pump & Machinery Corp., Holyoke, Mass.

Average Life Rating of Westinghouse 1000 Watt A-H 12 Mercury Lamp

The rated average life of the 1000-watt A-H 12 quartz mercury vapor lamp manufactured by the Westinghouse Lamp Division, Bloomfield, N. J., has been increased from 3000 hours to 4000 hours. The change applies to all lamps now in stock.

The A-H 12 lamp is finding wide acceptance in lighting large industrial areas, particularly when the mounting height must be high, or when the room is relatively narrow. The new life rating makes it the most economical Westinghouse mercury lamp for such service.

For further information, write the Westinghouse Lamp Division, Bloomfield, N. J.

Materials, Plant Capacity A '51 Bearing Problems

Availability of raw materials and plant capacity hold the answer to whether the anti-friction bearing industry's output in 1951 will approach record wartime levels.

The biggest year since 1943–44, when the industry turned out a half-billion dollars worth of ball and roller bearings at current prices, is in sight, predicts R. H. DeMott, president of SKF Industries, Inc., but a materials pinch already is clouding the picture.

"The immediate problem is to get the steel and other materials that are necessary to maintain the nation's productive system at peak efficiency," he said in discussing the outlook for the new year.

"Our mobilization program will be seriously harmed if we permit our industrial plants to run down," he declared. "They just won't be able to do the right kind of job if the materials that keep machines running are not available."

A large-scale mobilization program is almost certain to tax present manufacturing facilities, making new plants necessary, he said.

DeMott, chairman of the Anti-Friction Bearing Manufacturing Association defense

Continued on Page 60

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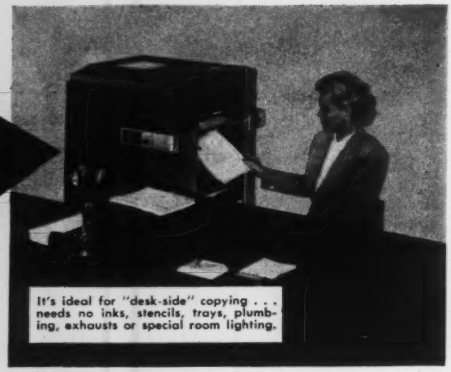

It's ideal for "desk-side" copying . . . needs no inks, stencils, trays, plumbing, exhausts or special room lighting.

Uses BW Diazo process, long employed by industry, to make exact low-cost positive copies. *First* machine specifically designed to use this quick, clean, easy process *anywhere* in your office.

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committee, said government cutbacks in the supply of copper will ultimately mean drastic curtailment of bearing production. Copper is a basic ingredient of bronze used widely in making bearing retainers.

"Under present allocations, a substantial reduction in the amount of bearings for such important defense items as electric motors, machine tools, traction motors of Diesel-electric locomotives, pumps and blowers is inevitable," he said.

While the problem now is to obtain an adequate supply of materials to meet current schedules, another pressing problem for the future, the SKF official continued, is the adjustment of the industry to fluctuating demands.

"What may happen, once the nation's mobilization program gets into full swing, is that there may be more demand for certain types and sizes of bearings than the industry now is fully equipped to produce," DeMott said.

"How well the transition is made from civilian to military production will depend in large part on how much advance planning is done by government and how quickly its ideas are communicated to the industry."

DeMott said the anti-friction bearing industry should be in a better position to meet defense needs as a result of millions of dollars spent for postwar modernization and expansion.

SKF, which produced millions of bearings for tanks, planes and other military equipment during the last war, will continue to enlarge its facilities and modernize equipment, he said.

SKF Sales of Textile Bearings at New High

Philadelphia—Sales of anti-friction bearing equipment for textile machinery are now at the highest level in the history of SKF Industries, Inc., R. H. DeMott, vice president, announced here recently.

Incoming orders for roller bearing spindle bolsters during the first eight months of this year are approximately 50 per cent ahead of 1949, he reported, while orders for tape tension pulleys are expected to exceed those for any previous year.

SKF is a major supplier of bolsters and pulleys which are essential in obtaining a uniform twist in the spinning of cotton and synthetic fibers.

The exceptionally strong demand for equipment that turns on ball and roller bearings, DeMott said, "reflects the industry's vigorous drive to improve its economic position by producing more and better goods at less cost.

"Textile manufacturers are vitally interested in anything that will give them a competitive advantage. New equipment that reduces by the merest fraction of a penny the cost of producing a pound of material is finding a ready market."

Because of the large number of obsolete machines, he added, the industry's broad expansion and modernization program "should continue for some time to come."

Quality Improved—Total Costs Reduced Over 50%

The Eddystone Division Shops of The Baldwin Locomotive Works recently installed a Reed A32 Cylindrical Die Thread Roller for rolling Class 5 threads up to 1⅛" diameter on cylinder head studs and connecting rod bolts used in their Diesel Locomotive Engines.

• Keep Informed

Manufacturing savings with the Reed Thread Roller have amounted to over 50% of the total cost of the bolts and studs, thus

enabling the machine to pay for itself in two months. These savings have been made possible, on the studs, by the rolling of the threads, using ground bar stock of diameters smaller than previously used, and eliminating the undercutting of the portion of the stud between the threads. Connecting rod bolts were redesigned for rolling with costs reduced as much as 67%.

Threads are produced with a high degree of surface finish, giving greater content of the external thread with the mating part.

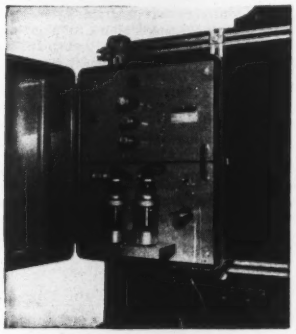
Pitch diameter tolerances are easily held because of accurate thread form, lead, taper, and roundness, provided by the thread rolling process.

Subjected to high stresses, the thread must be strong and of superior quality and held to rigid inspection requirements.

The uniformity with which these exacting tolerances are maintained insures an accurate fit of each stud in the cylinder block and reduces inspection and assembly costs considerably

New Electronic Side Register Control Announced by G. E.

A new electronic side register control that automatically and accurately maintains the lateral position of a moving web of material on slitting, re-winding, and other processing machines has been announced by General Electric's Control Divisions.



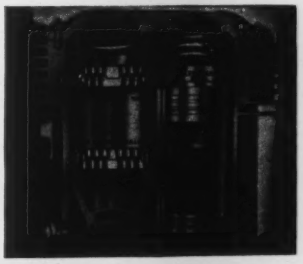
Designed to increase production by stepping up machine speeds and to minimize waste, decrease costs, and provide a more uniform product, the new side register control responds to a signal from a printed line on paper, plastic, or cloth of 1/32-in. minimum width. According to G-E engineers, the control ignores all signals from printing adjacent to the guide line on the trailing edge of the scanning sweep. It also follows broken lines of the same width, and will not change web position if the web breaks. Instantaneous response is provided for errors as small as .001 in. or less, they said.

Two components make up the new side register control: a rotary lens web scanner, and a thyratron control panel.

The scanner features a tilting mounting bracket with adjustable stops to allow operation on either diffused or specular scanning. The direction of scanning can be selected by a panel-mounted switch, and the red- and blue-sensitive phototube, provided with the equipment, will handle most color contrasts.

Capable of handling motors up to 2/3 horsepower, the thyratron reversing motor control feeds power to the correction motor so that correction is proportional to the amount of error detected by the web scanner. The thyratron control panel offers compact construction, easy accessibility, and simplified wiring.

NO OTHER COMPRESSOR VALVE OFFERS YOU ALL OF THESE ADVANTAGES



1 LARGER GAS PASSAGE AREA
From 20% to 100% increased valve area handles more and colder gas; a colder therefore denser gas costs less to compress.

2 LARGER VALVE AREA
Raises back and lowers head pressure, consequently reduces compression ratio—saving more power.

3 NOISELESS
Smooth running—with less power—at higher speeds without overheating.

4 SAFE
No castings used—therefore no invisible blow-holes or cracks which insures safety of operation. Gas passages drilled, slotted and milled smooth—hence less friction.

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Made to the highest standard of workmanship — on special machines — by craftsmen — in a modern and well equipped shop—designed to give long life under the severest conditions.

LET US SHOW YOU WHAT VOSS VALVES CAN DO FOR YOU
We will be glad to submit estimates if you will send us the name, bore, stroke and speed of your air, gas, or ammonia compressors of any type or size.

VOSS LONG LIFE COMPRESSOR VALVES

VOSS VALVES are indispensable for use where loads are heaviest—where safety and reliability are paramount. They run smoothly—with less power—at higher speeds — without overheating. You can replace your present valves with VOSS VALVES without any change in your compressor.

J. H. H. VOSS CO., Inc. 785 East 144th Street NEW YORK 54, N. Y.

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Foresees Great Future For Ductile Iron

Swampscott, Mass.—A prophecy that Ductile Iron will become the third most important engineering material tonnage-wise following steel and gray iron was made today by A. P. Gagnebin of The International Nickel Co. at the Massachusetts Institute of Technology Conference on Ductile Iron held at the New Ocean House, Swampscott, Mass.

In the paper entitled "Status of Ductile Iron in American Industry" the author described the properties, types of castings, tonnages of production to date, and special features for future uses of this new material. The amazing combination of Ductile Iron's properties, he said, include the process advantages and fluidity of cast iron with many of the strength properties of steel. Mr. Gagnebin claimed Ductile Iron has the strength of popular grade commercial steel castings with the wear resistance and castability of gray iron. He further predicted that the annual production of this amazing new material holds promise of reaching between two and five million tons annually in the next few years.

The author pointed out that these new metallurgical developments will help conserve the use of manganese which currently is difficult for the United States to import. Mr. Gagnebin is a member of International Nickel's Development and Research Division located in New York.

• BUSINESS CHANGES

28% Increased Space For Leeds & Northrup

Acquisition of approximately 85,000 square feet of additional floor space by Leeds & Northrup Co., Germantown manufacturer of electrical measuring instruments, automatic controls, and heat-treating furnaces, has been announced by C. S. Redding, president of the 50-year-old firm. "This space," said Mr. Redding, "will enable us to increase our production and also improve our delivery and other service facilities. We will transfer some operations to this new space; however, the principal manufacturing and other activities of the firm will continue to be centered at the main plant, 4901 Stenton Avenue."

Continued on Page 62

• DIRECT HEATING OF VAPORS
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If your plant requires
• DOWTHERM INDIRECT HEATING
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Every day more than 750, oil and gas fired, Petro-Chem Iso-Flow installations in the petroleum, chemical and allied industries, demonstrate the efficiency of their design and installation.

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Representatives:

Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh Faville-Levally, Chicago • Lester Oberholtz, Calif.

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The added space is in two parcels. One is a 3-story, 50,000 square foot building at Castor and Sedgley Avenues, leased from William D. Whitaker and formerly used as a spinning mill. The other property totals 35,000 square feet at Collum and Rubicam Streets, Germantown, and was recently purchased by Leeds & Northrup for $92,500 from the Nathan Neuman estate. Together, they increase the company's Philadelphia floor space by 28%, to a total of almost 10 acres.

Roots-Connersville Appoints Koerner Engrg. & Supply Co.

Roots-Connersville Blower Corp., Connersville, Ind., announces the appointment of the Koerner Engineering & Supply Co. of Portland, Oregon, as exclusive sales agents for all R-C products in the states of Oregon and Washington, C. L. Koerner, who heads the organization, has had considerable paper mill experience in the area assigned to his firm. Roots-Connersville manufactures rotary positive and centrifugal blowers and exhausters, cycloidal vacuum pumps, positive displacement meters, and inert gas generators. They are represented in twenty industrial areas throughout the U. S.

Westinghouse To Build New Small Motor Plant in Indiana

The Westinghouse Electric Corp. will build a new plant for the production of small electric motors in Union City, Indiana, it was recently announced by C. C. Shutt, manager of the Westinghouse Small Motor Division, whose headquarters are at the Division's main plant in Lima, Ohio.

The new plant will be a modern one-story structure containing both manufacturing and office space. When in full operation the plant will employ approximately 50 men and women. Production is expected to start late in 1951.

"This additional facility is necessary because of increased demand for fractional horsepower motors arising from the nation's defense program and from increased building of industrial plants," Mr. Shutt declared. 'In the event of complete mobilization for national defense, the facilities of this new plant will be devoted to the production of motors essential to that program."

In charge of the new Union City plant will be Ralph E. Davis, who has been plant superintendent at the Westinghouse small motor plant at Bellefontaine, Ohio.

Mr. Shutt also recently announced plans for additional expansion of the Westinghouse Small Motor Division in Lima. There two buildings, totaling some 120,000 square feet of floor space, have been leased. The larger building will be used to produce machined parts needed at the Company's main Lima plant for military production. The second building will be devoted to office and storage use. The Division's industrial sales and industrial engineering departments now are located at this second site.

New Distributors For Tube Turns

John G. Seiler, executive vice president and general sales manager of Tube Turns, Inc., has announced the appointment of the Bethlehem Supply Company and the Bethlehem Supply Company of California as distributors of Tube-Turn welding fittings and flanges.

The Bethlehem Supply Company is a subsidiary of the Bethelehem Steel Company and has its main offices in Tulsa. Its oil country stores and service organization cover Arkansas, Colorado, Illinois, Kansas, Louisiana, Mississippi, New Mexico, Oklahoma, Texas and Wyoming. George Thompson is

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president and C. R. Zimmerman is executive president.

The Bethlehem Supply Company of California is a subsidiary of the Bethlehem Pacific Coast Steel Company. Its main offices are in Los Angeles, and its oil country stores and service organization are located in twelve strategic areas in California. Wendell M. Jones is president and J. W. Hollingsworth is general manager in charge of sales.

Tube Turns, Inc. is the nation's oldest and largest manufacturer of seamless welding fittings for industrial piping.

Link-Belt Opens New Pittsburgh Factory Branch Store

For better service to industries in the greater Pittsburgh area, Link-Belt Co. has constructed and is now operating a new Factory Branch Store located at 5020 Centre Ave., Pittsburgh 13, Pa. This new building provides ample space for stocking popular Link-Belt power transmission and materials handling products and serves as headquarters for the increased Pittsburgh personnel.

Mr. Otto W. Werner, District Manager, points out that Link-Belt has furnished materials handling, processing and power transmission machinery for many of the most successful installations in the steel, coal, aluminum, glass and other important industries in the greater Pittsburgh area.

The new store is easily reached by all forms of transportation, being situated just three miles from the Golden Triangle, and only one block from the well-known intersection of Morewood Ave. and Baum Blvd. There is ample parking space on the property. Street car service is available on Centre Avenue and bus lines operate on Baum Blvd. The Shadyside Station on the main line of the Pennsylvania Railroad is immediately adjacent to the property.

New Morse Western Representative

Mr. R. J. Howison, General Sales Manager of the Morse Chain Co., Division of Borg-Warner Corp., Ithaca and Detroit, announces that Mr. Carlton R. Becker has been recently appointed as Morse Western Factory Representative.

He will supervise the sales of Morse Mechanical Power Transmission products in the eleven states west of and including Montana, Wyoming, Colorado, and New Mexico. Mr. Becker's headquarters are at 1571 Harding Ave., Pasadena 7, California.

Mr. Becker formerly was associated with the J. W. Minder Chain & Gear Co., Los Angeles, who are Morse Chain distributors in this area.

New Field Assignments by Bailey Meter Co.

To meet increased demands for expert engineering services in power and process fields, Bailey Meter Co., manufacturer of Instruments and Controls, has assigned five engineers to new branch office posts. The five men are all graduates of the company's intensive training program which consists of classroom, factory and field training in the theory and practice of measurements and controls as applied to power and process problems.

The names and new business addresses of the five engineers are: P. K. Bolyard, 184 Pryor Street, S.W., Atlanta 3, Georgia; George J. Dunegan, 424 Sharon Building, San Francisco 5, California; L. F. Monahan, 1506 Kearney Street, Denver 7, Colorado; R. E. Paulson, 7725 Ward Parkway, Kansas City 5, Missouri; O. M. Thompson, 2509 Carew Tower Building, Cincinnati 2, Ohio.

4-cycle
Single Cyl.
3 to 9 hp.

4-cycle
2 Cyl.
7 to 13 hp.

V-type
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15 to 30 hp.

As a potential or present user of internal combustion engines, you will readily recognize the advantages of dealing with an outstanding leader in this field.

Because constant engineering effort and manufacturing skill are applied entirely to the improvement and large volume production of WISCONSIN HEAVY-DUTY AIR-COOLED ENGINES, in a complete, all-purpose power range, you have the best assurance not only of dependable power units ideally suited to your power applications but, of equal importance . . . you have, here, the world's most dependable source of supply both for engines and original factory parts.

Supporting this endeavor are key distributors of impressive recognition in the territories they serve, and a staff of competent Wisconsin Motor Corporation field men, in close liaison between factory and customer. Your best interests are our primary interest.

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Cochrane Acquires Pottstown Metal Products Co.

Cochrane Corporation, Philadelphia, manufacturers of water conditioning equipment and steam power plant specialties, announces the acquisition of Pottstown Metal Products Co., Pottstown, Pa., which will be operated as an independent subsidiary of the Cochrane Corporation. The transaction, which acquired practically all of the capital stock of the Pottstown Company, was for cash. Organized in 1927, Pottstown Metal Products Company has been one of Cochrane's principal sources for steel heater, softener and filter shells and for numerous weldments. Many other firms have been customers of Pottstown Metal Products in the past and it is planned to develop that phase of the business and to widen the scope of the company's activities.

T. E. McBride, president of the Cochrane Corp., becomes president and treasurer of Pottstown Metal Products, V. A. Rohlin is vice president, Raymond A. Piersol is vice president and general manager, and George Mease is plant superintendent.

Du Mont Electronic Parts Division Representatives

The appointment of two more sales representatives to cover the jobbing trade, is announced by the Electronic Parts Division of Allen B. Du Mont Laboratories, Inc., East Paterson, N. J.

John O. Olsen Co., 1456 Waterbury Road, Cleveland, O., will handle the Du Mont Inputuner and other TV components in the territory including Ohio, Kentucky and West Virginia; the State of Pennsylvania excluding all territory east of Harrisburg; and Garrett, Allegany and Washington Counties in the State of Maryland.

L. D. Lowery, Inc., 1343 Arch St., Philadelphia, Pa., have been assigned the territory including the State of New Jersey south of and including the City of Trenton; the State of Pennsylvania east of but excluding the City of Harrisburg; the State of Delaware; the State of Maryland excluding Garrett, Allegany, and Washington Counties; the District of Columbia, and the State of Virginia.

With these latest appointments this Du Mont division continues to round out its nation-wide coverage of the jobbing trade through sales representatives. Sales to manufacturers, however, continue to be handled directly by the Electronic Parts Division of Du Mont.

Flexitallic Changes

Flexitallic Gasket Co., Camden, N. J. announces the addition of three new distributores and two new agents to its field organization.

Tate Engineering & Supply Co., Inc., Baltimore, Md., is a new Flexitallic Distributor and will serve Maryland and Washington, D. C.

A. L. Crump & Co., Chicago, Ill., is a new Flexitallic Distributor and will serve northern Indiana and Illinois.

Carl Grimes & Co., Des Moines, Ia., is a new Flexitallic Agent and will serve western Iowa.

Frank Valetti & Co., Philadelphia, Pa., is a new Flexitallic Agent and will serve the Marine industry within the limits of Philadelphia.

Continued on Page 65

NOW Standardization on BOSTON GEARS pays 20%

Notice to Designers

REMEMBER *when you specify Gears*

Standardized BOSTON 20° Pressure Angle GEARS from stock

SAVE 20% of your $ per HP

20° Boston Gears of the same pitch average 20% lower cost per horsepower delivered than 14½° gears

SAVE 20% in space

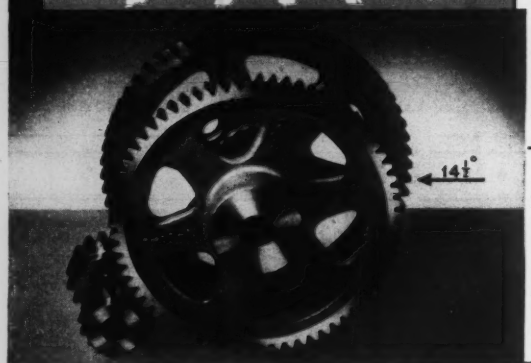
20° Boston Gears of finer pitch may be used for equal work — average space saving 20%

SAVE 20% in purchase price

20° Boston Gears of finer pitch may be used for equal work — average cost saving 20%

Average increase in HP per lb. of gear weight — 25%

when you standardize on Boston 20° Gears



The Boston Spur Gears cut 20° Pressure Angle in the foreground do the same job as the 14½° Angle Gears in back. A 20% saving in space — 20% saving in cost.

Design Standardized BOSTON 20° Gears into your equipment. Consult Boston Gear Catalog No. 55. Free copy mailed on request.

Boston Spur Gears cut 20° Pressure Angle are *stocked* in 12-10-8-6 and 5 pitch. *All* Boston Steel Miter Gears are now stocked in 20° Pressure Angle.

BOSTON GEAR WORKS

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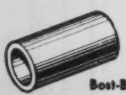
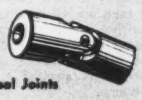
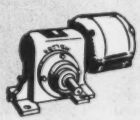

Bost-Bronz Bearings


Universal Joints

Sprocket and Chain

Reductors

Pillow Blocks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Bearings

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Carey Mchy. & Sup. Co.
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BIRMINGHAM, ALABAMA
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H. L. Dickie
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Root, Neal & Co.
64 Peabody St.
CHARLOTTE, NORTH CAROLINA
Matthews-Morse Sales Co.
900 S. Mint St.
CHICAGO, ILLINOIS
Boston Gear Works
935 W. Washington Blvd.
Chgo. Pulley & Shafting Co.
23 N. Desplaines St.
Samuel Harris & Co.
114-116 N. Clinton St.
Perar Trans. Equip. Co.
1245 W. Fulton St.
CINCINNATI, OHIO
Queen City Sup. Co.
Pearl & Elm Sts.
CLEVELAND, OHIO
Bearing Distributors, Inc.
2818 Carnegie Ave.
Boston Gear Works
211 St. Clair Ave., N. W.
Mau-Sherwood Sup. Co.
800 Lime Road
COLUMBUS, OHIO
Ohio Trans. Co.
666 Parsons Ave.
DALLAS, TEXAS
Geo. J. Fix Co.
2413-15 Commerce St.
DAYTON, OHIO
Klinger-Dills
1041 So. Patterson Blvd.
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Western Bottled & Packing Co.
1720-28 Wazee St.
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Standard Bearings Co.
1014 Grand Ave.
DETROIT, MICHIGAN
Chas. A. Strelinger Co.
149-165 E. Larned St.
EVANSVILLE, INDIANA
Bearings Service Co., Inc.
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Salitor-Holden, Inc.
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Vonnegut Hardware Co.
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JACKSONVILLE, FLORIDA
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410 E. Depot Ave.
LANCASTER, PENNSYLVANIA
Harr & Co., Inc.
Prince & Chestnut Sts.
LONDON, ONTARIO
Ronald-Coventry, Ltd.
277 Piccadilly
LONG ISLAND CITY, NEW YORK
L. C. Bigbie & Co., Inc.
11-06 Jackson Ave.
LOS ANGELES, CALIFORNIA
Andrews Hardware & Metal Co.
334 S. Main St.
Garratt Supply Co.
3844 S. Santa Fe Ave.
LOUISVILLE, KENTUCKY
Industrial Equip. Co.
7th & Myrtle Sts.
MEMPHIS, TENNESSEE
Lewis Sup. Co.
Main at Butler Sts.
MIAMI, FLORIDA
Gamdas Corp.
2140-50 N. Miami Ave.
MILWAUKEE, WISCONSIN
Western Trans. Service Co.
319-331 East Clybourn St.
Wisconsin Bearing Co.
915-917 N. Market St.
MINNEAPOLIS, MINNESOTA
R. C. Duncan Co., 1300 4th St. S.
MONTREAL, QUEBEC
Ronald-Coventry, Ltd.
1006 Mountain St.
NEWARK, NEW JERSEY
Squier, Schilling & Skitt
419 Plane St.
NEW ORLEANS, LOUISIANA
McLellan A-C Sup. Co.
2375 Tchoupitoulas St.
NEW YORK, NEW YORK
L. C. Bigbie & Co., Inc.
250 W. 54th St.
Boston Gear Works, 480 Canal St.
Frank Tracy, Inc., 202 Centre St.
OAKLAND, CALIFORNIA
C. W. Marwedel
11th & Alice Sts.
PHILADELPHIA, PENNSYLVANIA
Morton Gear Works
Broad St. Car. of Lycoming & 16th Sts.
Lindsay, Oberholzer & Co.
4432 Ridge Ave.
Maddock & Company
42 N. Sixth St.
PITTSBURGH, PENNSYLVANIA
Somers, Fitler & Todd Co.
313-327 W. Water Street
PORTLAND, OREGON
Woodbury & Co.
133 S. W. 2nd Ave.
PROVIDENCE, RHODE ISLAND
Machine Parts Corp.
271 Washington St.
QUEBEC, QUEBEC
Ronald-Coventry, Ltd.
5 Bourlamaque Ave.
QUINCY, MASSACHUSETTS
Boston Gear Works
14 Hayward St.
RICHMOND, VIRGINIA
Industrial Sup. Co.
15th & Franklin Sts.
ROCHESTER, NEW YORK
John M. Forster Co.
110 Mill St.
ST. LOUIS, MISSOURI
Calcord-Wright Mchy. & Sup. Co.
1223-1229 N. Broadway
SAN FRANCISCO, CALIFORNIA
Boston Gear Works
123 10th St.
C. W. Marwedel
1235 Mission St.
SEATTLE, WASHINGTON
Cragin & Co.
932 Fourth Ave. S.
SPRINGFIELD, MASSACHUSETTS
Boston Gear Works
29 Cottonington St.
SYRACUSE, NEW YORK
Syracuse Sup. Co.
314 W. Fayette St.
TAMPA, FLORIDA
Southern Pump & Sup., Inc.
902 Twiggs St.
TOLEDO, OHIO
Ohio Belting & Trans. Co.
406 Orange St.
TORONTO, ONTARIO
Ronald-Coventry, Ltd.
50 Edward St.
TRENTON, NEW JERSEY
Wiley-Hughes Sup. Co.
801 New York Ave.
VANCOUVER, B. C.
Ronald-Coventry, Ltd.
1066 Seymour St.
WATERBURY, CONNECTICUT
White Supply Co.
297 Thomaston Ave.
WILKES-BARRE, PENNSYLVANIA
Holmes Metallic Co.
319-321 S. Main St.
WINSTON-SALEM, NORTH CAROLINA
Kester Machinery Co.
300 E. 3rd St.
WORCESTER, MASSACHUSETTS
W. M. Steele Co.
171 Fremont St.

BOSTON Gear
STOCKS ARE Near

• Keep Informed . . .

Southern Marine Supply Co., Inc., Savannah, Ga. is a new Flexitallic Distributor and will serve the Marine industry within the limits of Savannah.

Transmission Engineering Co., San Francisco, Calif., a Flexitallic Distributor, is expanding its service to include the Marine industry in that area.

Eagle Asbestos & Packing Co., New Orleans, La., a Flexitallic Distributor, will now serve both Industrial and Marine industries in eastern Louisiana and southern Mississippi.

• LATEST CATALOGS

Sier-Bath Gear Coupling Folder

A new 4-page folder on the Sier-Bath Gear Coupling is now available from the Sier-Bath Gear & Pump Co., Inc., 9252 Hudson Blvd., North Bergen, N. J.

The bulletin illustrates and explains the simplified, 7-part construction of the Sier-Bath Gear Coupling, and compares it with other gear types to illustrate its size and weight advantages. A check list of advantages is also given, as are photographs and descriptions of typical installations.

The folder gives detailed plan drawings and specifications for Standard, Mill Motor, Vertical Shaft, Spacer and Floating Shaft types. Service factors for all types of equipment and information on how to select the right coupling are also given.

Ball Bearing Catalog for Engineers

The new 20th Edition of the New Departure ball bearing catalog, now ready for distribution, contains numerous added features of interest and value to ball bearing users.

Selection of bearing type and size for various conditions of load and speed is considerably simplified and illustrated by examples.

Load rating tables now give both radial and thrust capacities for all bearings except those types which are designed for certain specialized services, and speeds now have been arranged to include those for synchronous motors.

Several more types of single row and double row angular contact bearings have been added.

Copies of the new catalog will gladly be mailed upon request. Address—New Departure Division, General Motors Corp., Bristol, Connecticut.

New Micarta Gear Booklet Offered By Westinghouse

Micarta-gear-manufacturing know-how is offered to equipment manufacturers in a new 15-page Micarta gear booklet available from the Westinghouse Electric Corp.

The booklet serves three purposes: (1) it gives an introduction to Micarta gearing; (2) it provides machining, designing, and application information; (3) it adds new manufacturing information to that already known.

In stressing the adaptability of Micarta gears to service that demands quiet, dependable, and lengthy operation, the booklet points out that Micarta gear material is available in plate form in sizes up to 36- by 36-inches with $1/32$- to 10-inch thicknesses. It can also be obtained in the form of blanks cut from plate.

An illustrated explanation of Micarta manufacture is given, and application rules for Micarta gears show the manufacturer how to make the best use of Micarta. Various tables, including a physical properties table, preferred pitch table, and a gear-data table for full depth teeth, are contained in the booklet.

Micarta-gear horsepower-rating formulas are illustrated with typical examples, and 57 successfull applications of Micarta gears are listed.

For a copy of Booklet B-4661, write Westinghouse Electric Corporation, Box 2099, Pittsburgh 30, Pennsylvania.

Bulletin On High Capacity Chlorinizer

Builders-Providence, Inc., Providence, R. I., has just issued a new bulletin (840-G27) on the new Model HCVS Volumetric Chlorinizer. This 4-page bulletin describes the high capacity visible flow Chlorinizer which is designed to meter chlorine gas accurately at rates from 100 to 6000 pounds per 24 hours.

The bulletin lists the many features of the Chlorinizer and shows a cut-away drawing of the functioning parts. An easily readable diagram shows how the operation of the the Chlorinizer is carried out. There is also a discussion of operation, safety features, rate of flow indicator, low maintenance costs, and installation.

Bulletin No. 840-G27 may be obtained on request to Builder-Providence, Inc., 345 Harris Avenue, Providence, R. I.

Detroit Stoker Bulletins

Bulletins covering a complete line of Detroit Stokers, including both Underfeed and Overfeed Spreader Stokers are available. Detroit Stokers are unsurpassed for their economy and dependability and features embodied in the various designs represent over 50 years of experience in stoker manufacture exclusively. Many types, sizes and capacities are available, which places this manufacturer in a position to recommend the stoker best suited for any individual requirement. All grades of Bituminous coal are successfully burned without expensive preparation. Operating costs are low, plant efficiencies may be raised to new standards and the capacities of present boilers increased through the use of Detroit Stokers. Proper design and application by experienced builders will produce best results.

New Allis-Chalmers Switchgear Bulletin

Allis-Chalmers indoor and outdoor switch gear for better protection and flexible control of power and distribution circuits is described in a new 20-page bulletin released by the company.

Reference is included in the bulletin to all types of Allis-Chalmers switchgear, indoor or outdoor, with removable or stationary circuit breakers; switchboards of all types; "Ruptair" replacement units; multi-circuit, single circuit and load center unit substations.

Standardization advantages of metal-clad switchgear construction are given along with a table of space requirements for standard low-voltage switchgear.

Copies of the bulletin, "Allis-Chalmers Switchgear," 18B6185A, are available upon request from Allis-Chalmers Manufacturing Company, 949 S. 70th Street, Milwaukee, Wisconsin.

Lefax 1951 Technical Data Catalog

Over 2000 listings of Lefax pocket-size technical books are contained in the newly revised 1951 Lefax Catalog. Condensed, Mathematically accurate source materials for engineers, construction men, technical workers and technical students. Of special interest to surveyors is the new Slope Correction Table which gives 2 minute correc-

Continued on Page 68

tion factors for distances up to 1000 ft. Also newly compiled is a Decimal Trig Table with natural functions worked out to 100th part of degree. Forty years of constant compiling, condensing, and revising have made Lefax the final authority on engineering, mechanical and mathematical data. Each book consists of approximately 140 pages of easily read tables and data in pocket-size, loose leaf form for handy reference right on the job. Subjects listed in the 1951 catalog include: Hydraulics, Machine Design, Piping Data, Surveying Tables, Metallurgy, Analytical Chemistry, Highway Engineering, Metals, Transformers, Relays, Meters, Electricity AC-DC, AC Motors & Generators, Architecture, Home Heating, Illumination, Electrician's Data, Builder's Data, Lumber Data, Air Conditioning, General Math, Physics, Chemical Tables, General Chemistry, Reinforced Concrete, Building Construction, Radio, Televeision & FM, Automotive Engineering Surveying, Mechanical Drawing, Machinist's Data, Trig-Log Tables, and many others. For more information and Free Catalog, write to Lefax, Philadelphia 7, Pa.

Power Equipment Bulletin

A new 28-page bulletin briefly presenting products commonly used on power generating, transmission and distribution systems has been released by Allis-Chalmers Manufacturing Co.

The bulletin covers generation, distribution and control equipment. Included under generation are steam and hydraulic turbines, generators and such auxiliary equipment as condensers, pumps and water conditioning.

The power distribution classification includes transformers, voltage regulators, unit substations and circuit breakers. Miscellaneous motor control, switchgear and voltage regulation equipment is covered as well.

While Allis-Chalmers has for years manufactured a complete line of equipment for the electric power industry, the bulletin makes no attempt to cover the company's products that are primarily industrial machines.

Copies of "Allis-Chalmers Power Equipment," Bulletin 25B6150C, are available upon request from Allis-Chalmers Manufacturing Co., 949 S. 70th Street, Milwaukee, Wisconsin.

Various Data Offered On Carbon, Alloy and Stainless Steel Pipe

A new data card on seamless and welded pipe of carbon, alloy and stainless steels is offered by The Babcock & Wilcox Tube Co. Table I lists dimensions in 16 sizes of pipe from $^1/_8$-inch to 8-inch nominal size, with five different weight schedules according to wall inches and inside diameter. Table II gives ASTM and ASME specifications with grades and analyses for various types of pipe for high-temperature and other services. The double card, TDC 138, is available on request to The Babcock & Wilcox Tube Co., Beaver Falls, Pa.

In addition to the seamless and welded pipe mentioned above, the company, with plants at Beaver Falls, Pa., and Alliance, Ohio, manufactures seamless and welded tubing in carbon, alloy and stainless steel grades for all mechanical and pressure applications.

New Jeffrey Catalog

The Jeffrey Manufacturing Co., Columbus, Ohio, announces a new Catalog No. A418 covering its complete line of Chains and Sprockets for both new and replacement service on elevating and conveying equipment, and for drives.

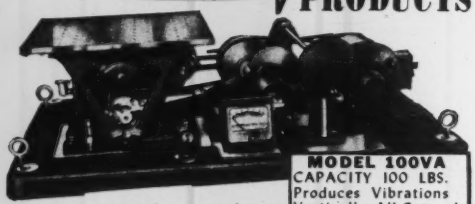
22 types of malleable, steel and alloy Chains as well as many types designed for special requirements are shown and described in detail. Particular emphasis is given to Drive Chains with all necessary information to simplify selection.

A copy of this New Catalog may be had by writing the company.

Screw and Rotex Pumps

Bulletins S-204 and Q-50 illustrate and describe Warren-Quimby Screw and Rotex Pumps, a recent addition to the Warren line of Centrifugal and Reciprocating Pumps. Both Screw and Rotex Pumps are built in two standard types, gear-in-head and external gear and bearing and each can be furnished for either horizontal or vertical mounting and in a variety of machinable metals or alloys. Warren-Quimby Screw Pumps are available in capacities up to 3000 O.P.M. and pressures up to 200 p.s.i. on low viscosity liquids and forpractically unlimited high viscosity liquids which will flow into the pump inlet. Warren-Quimby Rotex Pumps have capacities up to 100 O.P.M. and pressures up to 250 p.s.i. in the smaller sizes for fuel oil service and similar conditions. Larger sizes are limited to discharge pressure of 100 p.s.i. Warren Steam Pump Company, Inc., Warren, Massachusetts.

VIBRATION Fatigue Tests POINT THE WAY TO IMPROVED PRODUCTS



MODEL 100VA
CAPACITY 100 LBS.
Produces Vibrations Vertically. All Controls In Easy Reach.

You can be sure if your products pass a vibration fatigue test—substantiates design and construction materials—frequently exposes excessive material. Many things can be learned from tests. A "must" for electronic, aircraft and automotive parts and assemblies. Hundreds in use. Models to handle parts from 10 lbs. to 100 lbs.—choice of vertical or horizontal table movement. Frequencies of 600 to 3,600 v.p.m. Special machines to order. Catalog F contains treatise.

Made by makers of ALL AMERICAN PRECISION DIE FILING MACHINES

ALL AMERICAN Tool & Manufacturing Co.

1016 Fullerton Ave., Chicago 14, Ill.

THIS CATALOG in your hands..

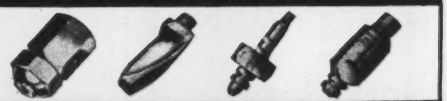
can be a good first step toward improving spraying operations in your plant. See for yourself how Spraying Systems' specialized experience in spray nozzle design and manufacture can work for you.

Get the EXACT spray nozzle type and size to fit your need.

WRITE for Catalog 22 . . . General Catalog
Catalog 23 . . . Pneumatic Atomizing Nozzle Catalog

SPRAYING SYSTEMS CO.
3265 RANDOLPH STREET • BELLWOOD, ILLINOIS

FOR BETTER INDUSTRIAL SPRAYING



DESIGNED AND BUILT BY SPRAY NOZZLE SPECIALISTS

LUNKENHEIMER
. . . The Steel Valve With A Priceless Ingredient

Into every heat of Lunkenheimer molten steel goes one ingredient that no other valve foundry can duplicate. It's not measured in ounces or pounds — but in generations . . . of tradition. It is pride in the kind of workmanship that has made Lunkenheimer universally respected as the one *great* name in valves.

Engineers are accustomed to dealing in facts — not intangibles. But every realistic engineer knows that molten steel is tricky stuff to handle. It demands *more* from the workman than simple attention. Quality valves—safe valves—are not made by formula alone, but by care . . . interest . . . pride in an unbroken tradition of fine workmanship. At Lunkenheimer, that tradition goes back to 1862.

Lunkenheimer's priceless ingredient will always be intangible, but it can be expressed in terms of one interesting fact: *there is no instance on record where a Lunkenheimer Steel valve has failed due to defective metal.*

Write for your copy of the Lunkenheimer Breech Lock Valve Brochure, a 16-page booklet describing the exclusive high-pressure Breech Lock line. Please use your company letterhead and address The Lunkenheimer Company, Box 360E, Cincinnati 14, Ohio.

STEEL • IRON • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-750-130

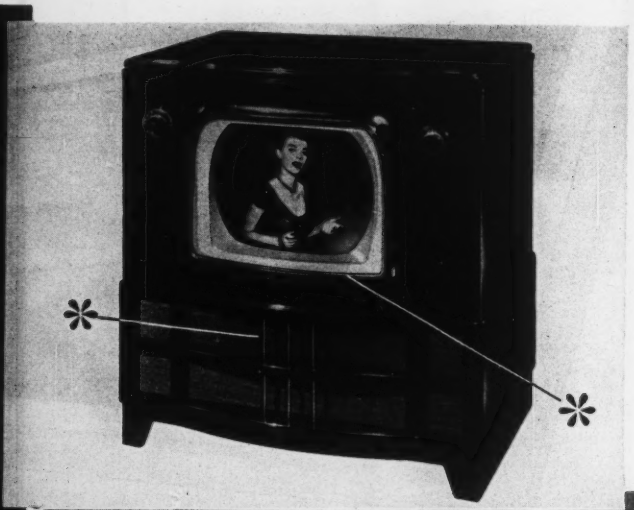
✻ REVERE COPPER AND BRASS *HELPS*

keep TV Sales Hot

FOR

~~CROSLEY~~

...makes Cabinets Cool and Classy



The newest Crosley Television Cabinets are striking examples of how copper and brass can be used to give products sales appeal as well as serve a utilitarian purpose.

All models, two of which are shown above, are equipped with gleaming bezels which frame the television screens. They are made for the Crosley Corporation from Revere 90-10 Commercial Bronze. The table model shown is equipped with two control escutcheons drawn from this same metal by the Rex Engineering Company, Cincinnati, Ohio. The table model also has two strips of .0016" Revere Soft Copper of 5½" width on the under side of the top of the cabinet. This acts as an insulator by conducting any heat generated, away from the wooden cabinets. For, although copper is the best heat conductor of the commercial metals, when highly polished it dissipates rather than absorbs heat.

Note on the console model, shown above, how the three Revere Brass Tubes add a touch of luxury and richness to the cabinet.

Perhaps Revere Copper or Brass or one of its other metals or alloys can help in the development and improvement of your product. Why not call the nearest Revere Sales Office and see?

REVERE

COPPER AND BRASS INCORPORATED

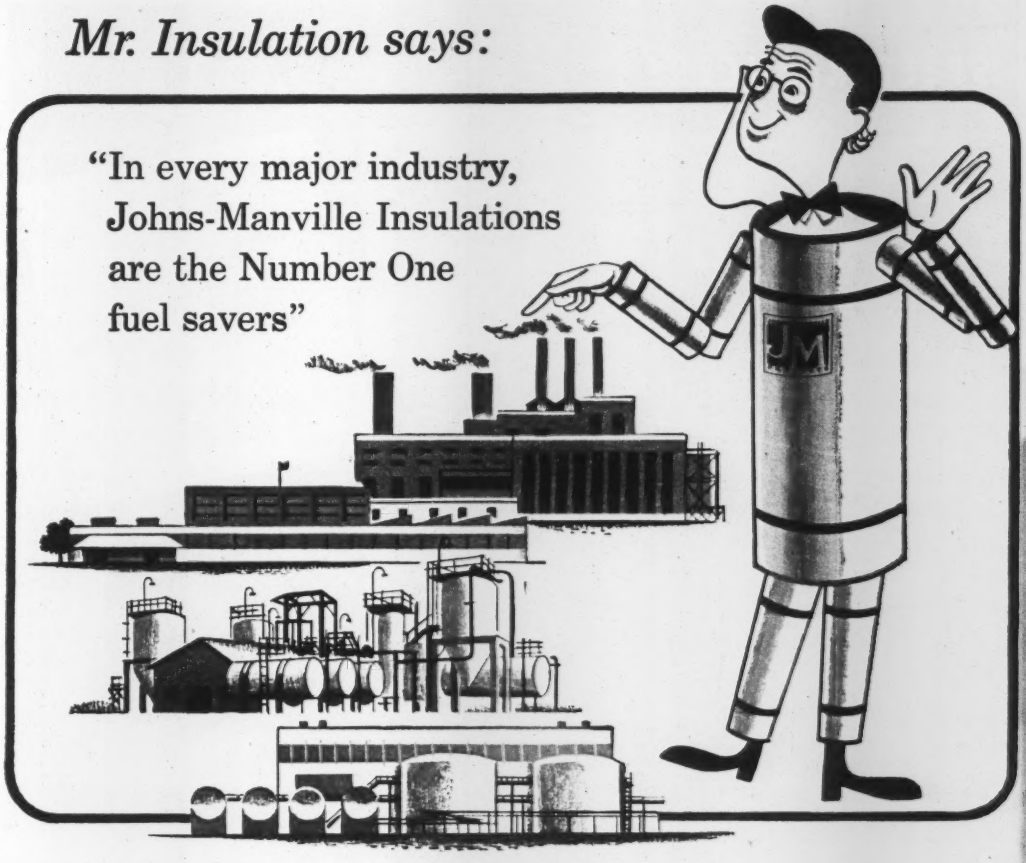
Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.

Sales Offices in Principal Cities, Distributors Everywhere

Mr. Insulation says:



IN PLANTS with stacks or stills, tanks or towers, the story is the same—"Insulation by Johns-Manville" means the maximum return on your investment. There are two good reasons for this:

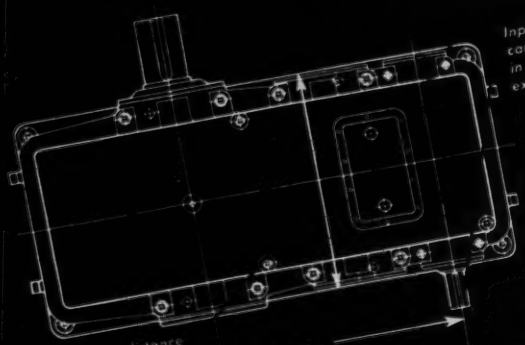
1. YOU GET THE RIGHT *MATERIALS*—From asbestos and other selected raw materials, Johns-Manville manufactures a wide range of industrial insulations for service from 400F below zero to 3000F above. If you need engineering advice in determining exactly the right one for your job, you can get experienced and authoritative assistance from your local Johns-Manville insulation engineer.

2. YOU GET THE RIGHT *APPLICATION*—Even correctly selected insulation needs proper application to permit it to serve at peak efficiency through the years. Here you can always count on J-M Insulation Contractors and their highly skilled mechanics. These organizations are trained in Johns-Manville application methods, and have generations of insulation experience behind them.

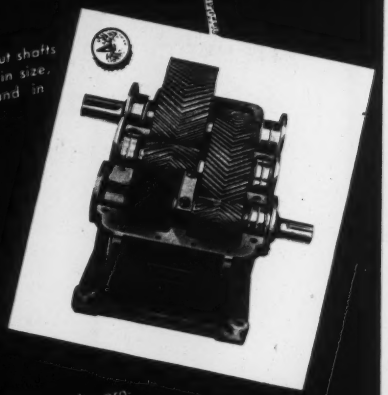
Why not get the complete picture? Call on insulation headquarters when your next job is in the planning stage. Just write Johns-Manville, Box 290, New York 16, N. Y.

Johns-Manville *first in* **INSULATIONS**

SPEED REDUCERS . . .



Input and output shafts can be varied in size, in material and in extension.



Relation of center distance and width of case gives latitude in proportioning gears to specific conditions.

Intermediate shafts proportioned for multiple stresses to which they are subjected.

Cases can be readily modified in certain dimensions and to meet problems in mounting.

PRECISION GEARS

The quiet, vibration-free performance you can expect from the herringbone gears used in Farrel speed reducers results from extreme accuracy of tooth spacing, contour and helix angle . . . qualities inherent in the Farrel-Sykes method of gear generation. Precision manufacture and highest grade materials contribute to long gear life.

STANDARD IN PRINCIPAL FEATURES BUT ADAPTABLE IN CRITICAL DETAIL

Farrel speed reducers have been developed for continuous, trouble-free operation under difficult service conditions. Gears, shafts and bearings are factored to safeguard against interruption of vital processes; gear cases are proportioned to withstand repeated heavy peak loads; joints are sealed to prevent entrance of dust and dirt.

But, that is not all. Without sacrificing the advantages of general standards, the design of these units permits an engineering freedom in proportioning gears, shafts, bearings and even some housing dimensions to meet specific load, speed and service requirements. This flexibility allows an engineering exactness in critical detail, which has resulted in the solution of innumerable application problems.

Write for further details. Ask for a copy of Bulletin 449—no cost or obligation.

FARREL-BIRMINGHAM COMPANY, INC. • ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y. *Sales Offices:* Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Cleveland, Cincinnati, Detroit, Chicago, Los Angeles, Tulsa, Houston, New Orleans.

FB-592-A

Farrel-Birmingham®

Cooper-Bessemer Corp. Calls Kodagraph Autopositive Paper

Low-Cost Insurance against costly shop errors

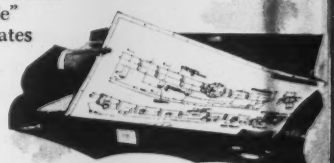
● Cooper-Bessemer, leading manufacturer of engines and compressors located in Mt. Vernon, Ohio, must supply its branch factory with intermediates (print-making masters) of home-office drawings.

But they realize that poor intermediates—like poor tracings—often produce illegible shop prints . . . which, in turn, can lead to costly errors on the production line.

It doesn't pay to take chances when thousands of dollars are at stake. Therefore, Cooper-Bessemer makes intermediates on Kodagraph Autopositive Paper, which reproduces original detail as dense photographic black lines on a clean, evenly translucent paper base.

These intermediates assure highly legible shop prints at Cooper-Bessemer's branch plant in Grove City, Pa. Even after hundreds of machine feed-throughs, Autopositives produce sharp, clean prints which are easy to read. And there's another advantage—print production is simplified, for Autopositives can be run at uniform, practical machine speeds—without frequent adjustments.

Photo-lasting in the files. The original drawings are 200 miles away, but Cooper-Bessemer's Grove City plant has full confidence in its 100% "Autopositive File"—no worries about intermediates fading, becoming brittle, or otherwise deteriorating. *Another important "extra."*



Extending Use of Autopositive. The assembly lines at Cooper-Bessemer's home plant are also seeing shop prints produced from Autopositives—will soon see many more. Plans are under way to protect some 50,000 valuable originals against the wear and tear of print-making by reproducing them on low-cost "Autopositive." The same production routine currently employed will be followed: *exposure* in a direct-process machine; *development* in standard photographic solutions.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction

- **It enables you, or your blueprinter, to produce positive photographic intermediates directly at a new low cost. No negative step—ever!**
- **It enables you to protect valuable originals from wear and tear.**
- **It gives you photo-lasting file copies.**
- **It restores old, worn drawings . . . reproduces opaques.**

MAIL COUPON FOR FREE BOOKLET

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y. 16

Gentlemen: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Paper.

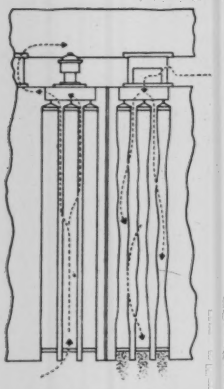
Name _____ Position _____
(please print)

Company _____

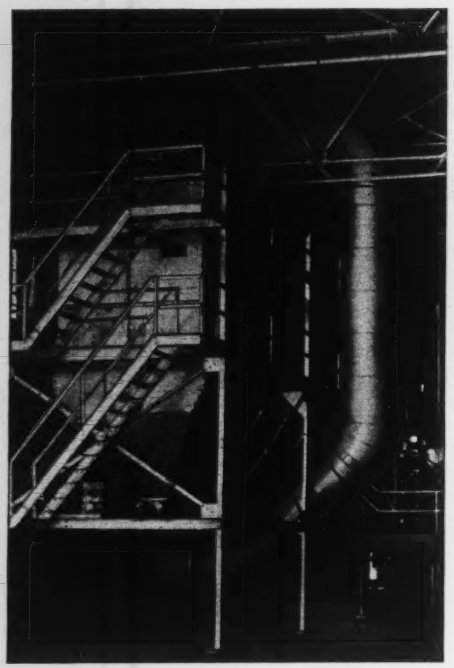
Street _____

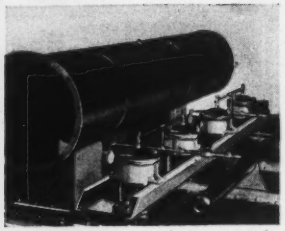
City _____ Zone _____ State _____

Kodak
TRADE-MARK



Shown above dust laden air moving upward, distending bags. Right half of cut shows reversed air current as bags are shaken and cleaned. At right the exterior of entire unit.





Close-up of automatic shaker units and an air reversal valve. Norblo bag shaking involves only one compartment at a time for only 10 seconds. Timing cycle is variable for dust loading, without shutting down.

Dust Control For Full Production

In a number of presently very important industrial jobs Norblo automatic bag type dust and fume collectors are making new records for high efficiency. The basic principles of bag cleaning, one compartment at a time, with combined shaking and air reversal, are shown above. Norblo automatic cleaning is variable for dust load; timing can be changed without shutting down the unit, and any compartment can be cut out for inspection or bag repair.

All of these features permit continuous heavy duty operation with maximum capacity of the cloth area.

Most of the modern smelter bag houses in North America, and most of the important cement and rock products plant installations in this country, are using Norblo dust collecting equipment.

Norblo also builds centrifugal and hydraulic dust collectors, exhaust fans and cement air cooling systems. Write for literature on any of these

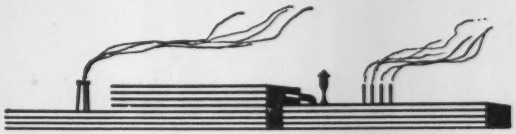
Norblo

Engineered Dust Collection Systems for All Industries

THE NORTHERN BLOWER COMPANY

6421 BARBERTON AVE. • CLEVELAND 2, OHIO

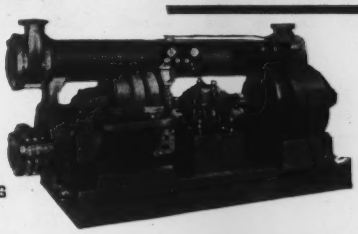
From the smallest to the largest . . . .



CARRIER CAN DO THE ENTIRE REFRIGERATION JOB . . . BETTER

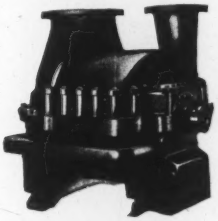
RECIPROCATING COMPRESSOR

The very latest design in large refrigeration compressors, incorporating such improvements as extreme compactness, automatic capacity control, and direct drive by motor, engine, or steam turbine through gears.



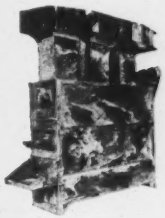
CENTRIFUGAL REFRIGERATING MACHINE

For large-scale air conditioning, low-temperature process refrigeration, direct or indirect cooling of water, brines, and other liquids, and for liquefaction of vapors and gases. Saves on operating, maintenance and space.



CENTRIFUGAL COMPRESSOR

Ideally suited to processes with heavy refrigeration requirements because it combines the advantages of direct expansion with the low operating costs and low maintenance of centrifugal compression.

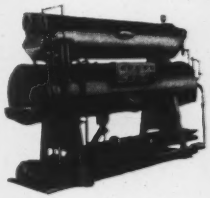


COLD DIFFUSER

The finest unit coolers for chilling work because they are hot-dip galvanized after fabrication, insuring long life even in corrosive atmospheres. They have external pumps and controls for accessibility, are easy to defrost, and are highly efficient.

EVAPORATIVE CONDENSER

Used with reciprocating compressors (in place of water-cooled condensers) to effect great savings in water, to simplify water supply and disposal, and to eliminate cooling towers and pumps. Capacities — 7 to 100 tons.



ABSORPTION REFRIGERATING MACHINE

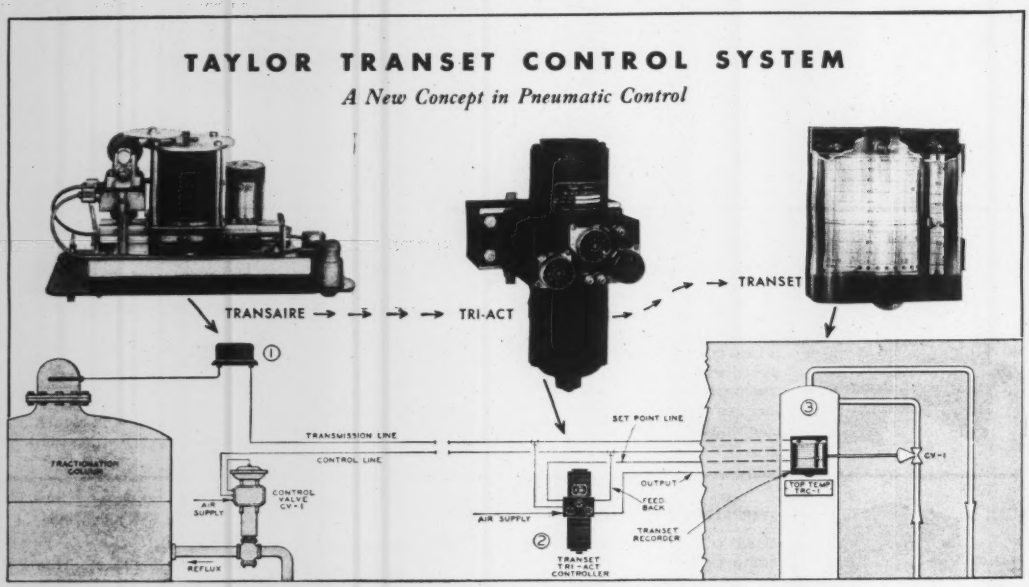
Uses heat to make cold. This machine produces chilled water as low as 36° F from either low or high pressure steam. It is safe, compact, completely automatic and has no moving parts. Available in capacities from 115 to 350 tons.

WHATEVER the size of your operation, Carrier has the answer to your refrigeration needs. There is a complete line of Carrier equipment in a wide range of capacities, making it possible to use the most suitable refrigeration on the job. And every unit is built in the Carrier tradition of leadership—designed for low maintenance and high efficiency. Leading companies have found that Carrier know-how has met the requirements of industry with equipment which has set new standards in dependable refrigeration.

CARRIER CORPORATION, SYRACUSE, NEW YORK

Carrier **AIR CONDITIONING • REFRIGERATION • INDUSTRIAL HEATING**

ORDERS POURING TAYLOR TRANSET*



If you want to eliminate overpeaking on start-up . . .

If you want to reduce the effects of load changes—

You ought to have at least one of these systems on test so that you'll know from first-hand experience how this new control circuit takes the evils out of Automatic Reset and gives the benefits of Rate Action with *stability*.

If you are engineering any new process, call in Taylor *right now*. With this new System you can specify the exact quality of control you want in advance. Components of the System can be put together like building blocks to meet final plant needs.

IN FOR THE NEW CONTROL SYSTEM

New Concept in Pneumatic Control is talk of Industry

NEARLY everyone in the industry is talking about the benefits of the new Taylor TRANSET Control System. Orders are literally pouring into Rochester. This new concept in pneumatic control, which gives unbelievably close control under adverse operating conditions, is a great contribution to all process industries. In almost any process, it will result in a higher yield of top quality product at lower cost.

The Taylor TRANSET Control System combines: **(1)** TRANSAIRE*, the force-balance temperature or pressure transmitters which have created new standards in measuring dynamic, or changing, temperatures and pressures. (The System works equally well with all types of transmitters.) **(2)** TRI-ACT*, the Controller which combines a wider range of response adjustments, an increased capacity relay air valve, and a new control circuit, to take advantage of the faster measuring systems. Can be locally or panel mounted. **(3)** TRANSET Recording Receiver, fits 3⅞" x 4½" panel opening, gives continuous 30-day chart record with 3 hours visible—especially adaptable to graphic panels. Other equally important features are: remote settings of control point, automatic-to-manual control, and instant check on controller performance and control valve position. Also available as an indicator.

Ask your Taylor Field Engineer or write to Taylor Instrument Companies, Rochester, N.Y., or Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.*

Taylor's Centennial ACCURACY FIRST SINCE 1851

HERE'S HOW YOU BENEFIT:

1—*More Accurate Measurement*
2—*Closer Control on Any Process*
3—*Higher Processing Efficiency*
4—*Start-Up With No Overpeaking*
5—*Faster Recovery On Load Changes*
6—*30-Day Chart Record On 4¾" x 5" Panel Space*
7—*Permits Specifying Instrumentation Before Finalizing Process Design Details.*

SEND FOR:

ASME Paper #50-A-100. It tells the theory of TRI-ACT Control.

Taylor Bulletin 98097. It gives details of design and construction.

*Trade-Mark

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

—when you need movable joints in piping

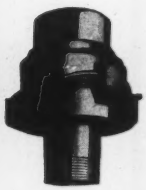
BARCO

"MOVE IN ANY DIRECTION"

Style 7-8

FLEXIBLE BALL JOINTS

Style 7-8B

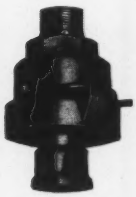


Style 7-8C

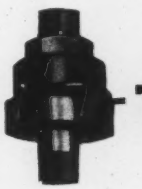
Style 7A-8

Style 7A-8B

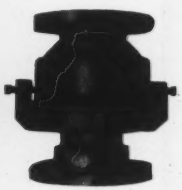
Style 7A-8C



Style 7C-8



Style 7C-8C



Style 7F-8F

—many other styles available.

Versatile!

THE BARCO Flexible Ball Joint is one of the most useful, most versatile fittings ever developed for application on piping conveying steam, oil, gas, water, air, chemicals, refrigerants, or other fluids. Find out how these simple, rugged, economical joints can help you:

- **Provide for movement in piping—up to 40° side flexibility in any direction, plus 360° rotating movement!**
- **Protect piping against strain, stress, settling, shock, or vibration!**
- **Overcome piping misalignment!**
- **Provide insulation barriers to stop electrical currents causing electrolysis in piping. Also used to prevent leakage of current from plating tanks.**

FIRE-PROOF! PRESSURE SAFE! No side thrust developed by pressure in piping even if one end is suddenly loosened. No danger of whipping! Available in materials suitable for temperatures from -50° to as high as 1,000° F.; for pressures from vacuum to 750 p.s.i. steam, or 6,000 p.s.i. hydraulic.

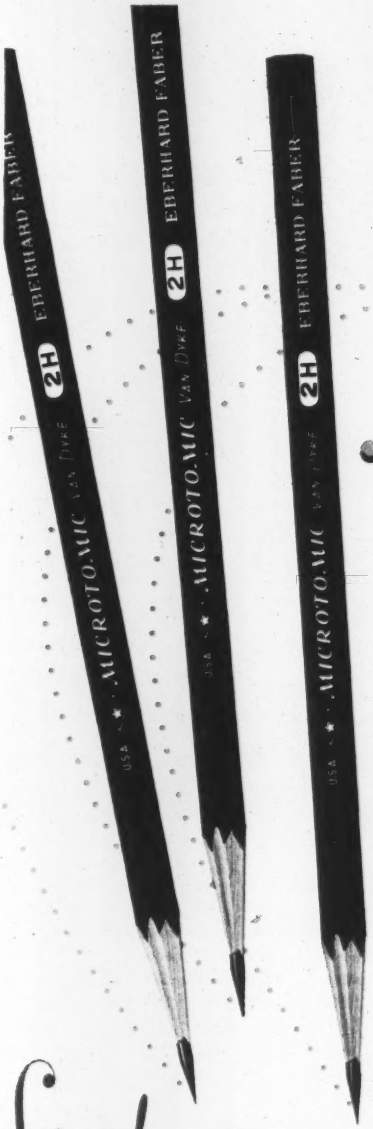
COMPLETE LINE—15 different sizes, ¼" to 12". Angle or straight, male or female threaded connections—flanged connections—welding ends for welded connections. Choice of seven different gasket materials to meet various service requirements, including "TEFLON" gaskets with stainless steel bodies for handling corrosive liquids or gases. Also magnesium bodies for light weight in large sizes. In ordering, specify service. *Write for latest, illustrated literature.* BARCO MANUFACTURING CO., 1821 C Winnemac Ave., Chicago 40, Ill. In Canada: The Holden Co., Ltd., Montreal.

BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE, SWIVEL, SWING AND REVOLVING JOINTS

Worldwide Sales and Service

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY



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ALWAYS IDENTICAL!

The all-new MICROTOMIC

Test 3 at our expense... you'll find every New MICROTOMIC Drawing Pencil IDENTICAL to every other one of the same degree! Eberhard Faber's newly-developed quality controls make it positive!

EVEN THEIR 'NEW LOOK' MAKES FOR BETTER WORK

NEW DUSK GRAY, selected by hundreds of draftsmen as the least distracting, most distinctive drawing pencil color. New 'bull's-eye' degree marking on 3 sides—always in sight!

LESS SMUDGE on your tracings, because New MICROTOMIC lines leave fewer loose, smearable particles! New Hi-Density Wood-clinched leads—stronger, tougher, slower wearing!

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Send me 3 New MICROTOMIC Drawing Pencils FREE. I'll test their uniformity against my present pencils. Degree..... *(specify only one)*

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WONDER WORKERS... that may help you!

IT SEEMS there's no limit to what Sylphon bellows assemblies and bellows devices can do—whenever there's a design problem involving control of temperatures or pressures.

For these wonder workers (a few are pictured above) are used in hundreds of ways. They open and close valves, dampers, etc., absorb expansion, provide packless construction—have many more useful applications.

But designing and producing them calls for specialists. That's where Fulton Sylphon and Bridgeport Thermostat *complete* the picture. When you call upon them, you get the unique advantages of nearly half-a-century of experience in this specialized field.

You get more, too. Skilled personnel—careful workmanship—the kind of service that meets your production schedules. Costwise, that can mean important savings for you.

We may have a ready-made control that will fit your product or product plans. If not, we'll work with you to develop and produce bellows assemblies and bellows devices that are *exactly* what you require. Wide range of metals and sizes—ample production facilities. Send for idea-filled catalog CK-1200.

TEMPERATURE CONTROLS

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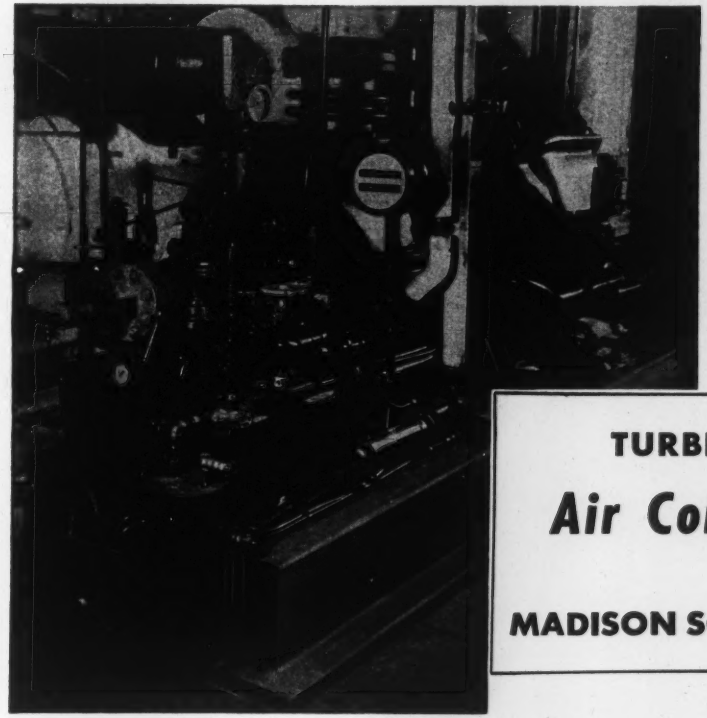
DIVISION
Knoxville 4, Tenn.

Robertshaw-Fulton CONTROLS COMPANY

BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.

The TERRY TURBINE



TURBINES FOR *Air Conditioning* AT MADISON SQUARE GARDEN

In 1925 Madison Square Garden installed three Terry Multi-Stage Turbines to drive air conditioning and refrigeration compressors. These units deliver 290 hp at 3500 rpm with steam conditions of 100 psi exhausting to a 26 in. vacuum.

After 22 years experience Madison Square Garden installed three more Terry Multi-Stage Turbines, one of which is shown above. This unit delivers 330 hp, at 5650 rpm, with steam at 100 psi exhausting to a 25 in. vacuum.

The same engineering talent and manufacturing facilities that produced these turbines are available to assist you in obtaining efficient power generation.

Any of our District Representatives will be pleased to give you full information on a turbine drive for your requirements. No obligation. May we send you descriptive bulletin?

TT 1184

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

it's New!

it's Different!

it's the strongest pipe wrench in the world!

–the revolutionary Walworth improved Walco®

Yes, this is it . . . the NEW Walworth *Improved* Walco pipe wrench—with every part scientifically designed and tested by engineers for strength, safety and ease of operation. Its instant bite, and accurately determined center of gravity, combine with its inherent strength and minimum of weight to make it the fastest-working, easiest-handling, best balanced, heavy-duty pipe wrench available today . . . a wrench specially designed to minimize operator fatigue.

All parts are made of forged steel. The housing and handle are projection welded—a structural weld—to form an integral unit. Both jaws are carefully machined, and all parts are heat-treated to give extra toughness, uniformity, and strength. Every Improved Walco far exceeds the requirements for Federal Specification GGG-W-651a for Type II Heavy Duty Adjustable Pipe Wrenches.

A flexible, double-acting, easily replaceable spring—an exclusive patented Improved Walco feature—gives the wrench fast, positive ratcheting action!

Ask your Walworth distributor about the new, Improved Walco today! Heft the new, Improved Walco . . . feel its perfect balance—every part is guaranteed by the Walworth Company, doing business since 1842.

Check these outstanding features

LIGHTER: Housing and Handle are projection welded to form one integral unit.

CORRECT BALANCE: Accurate, the correct location of the center of gravity determined by test.

STRONGER: Heat treated to eliminate brittleness . . . cracking.

FAST ACTING: Scientifically designed spring action insures positive ratcheting action . . . quick bite.

CALIBRATED PIPE SCALE: Built-in scale permits speedy adjustment to pipe size.

RENEWABLE PARTS: All parts are readily obtainable, and easily replaced without special tools; thus prolonging service life indefinitely.

RUST RESISTANT FINISH: Entire wrench is rust resistant — Nut and Jaws have a special electroplated zinc coating.

WALWORTH

valves...fittings...pipe wrenches

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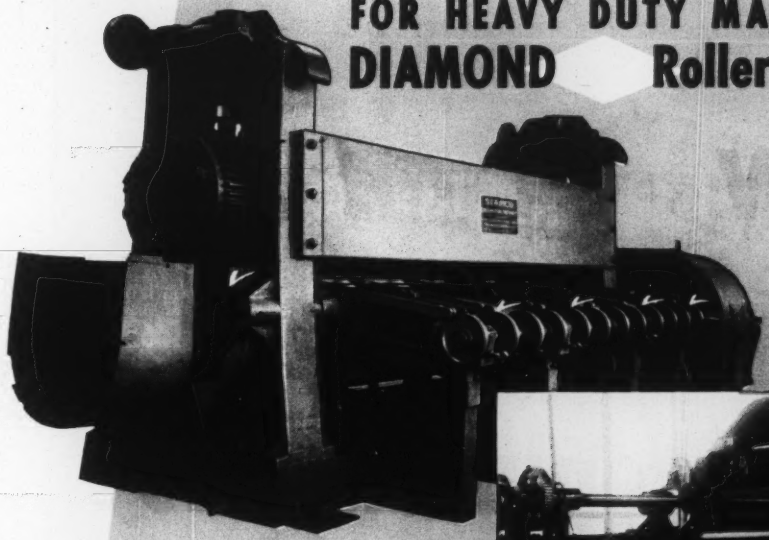
FOR HEAVY DUTY MACHINES, DIAMOND Roller Chains



Left: Stamco Corrugating Machine with feed table and main drive for this table from bottom roll driven by Diamond Roller Chain.

Modern Heavy Duty Machines Need Roller Chains of High Stamina

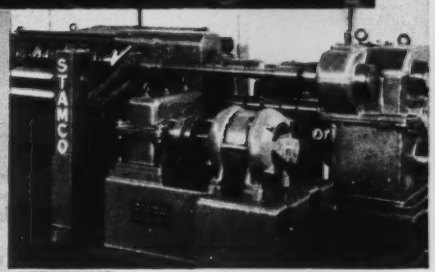
● For such heavy duty machinery for high speed packing, cutting and squaring of steel sheets—for corrugating culvert stock and similar work, The Streine Tool & Mfg. Company incorporate Diamond Roller Chains for many drives.

While this is a good example of heavy duty application, the reserve strength of all pitches of Diamond Chains has been demonstrated on drives ranging from fractional horsepowers to several thousand. The same durability and dependability, the non-slipping positive drive are important on all modern higher output machinery.

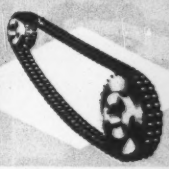
Practical recommendations by our experienced engineering staff are yours for the asking. . . . If you haven't a copy of Catalog 709, write for a copy today. DIAMOND CHAIN COMPANY, Inc., Dept. 413, 402 Kentucky Avenue, Indianapolis 7, Indiana.

Offices and Distributors in All Principal Cities

Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER



Above Middle: Portion of Stamco Pack and Resquaring Unit—electrically-operated guage for cutting sheets into multiples. Drivers for series of rollers and pinch roll are Diamond Roller Chains. Below: This is a 2-strand Diamond Drive on a sheet and plate machine.



DIAMOND ROLLER CHAINS

How you can up-grade valve replacements

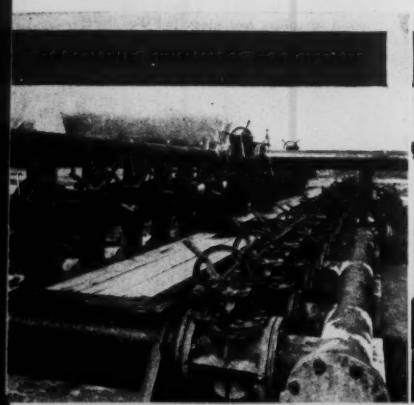
...without major investment

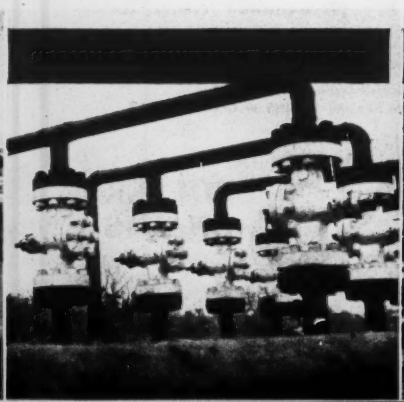
Why does a valve need replacing? Because it has either failed to operate, or cannot adequately handle the fluid. Replacing old style valves with like valves is usually force of habit—and it's easy to become a victim of habit. The way to break a bad habit is to substitute a new and better habit.

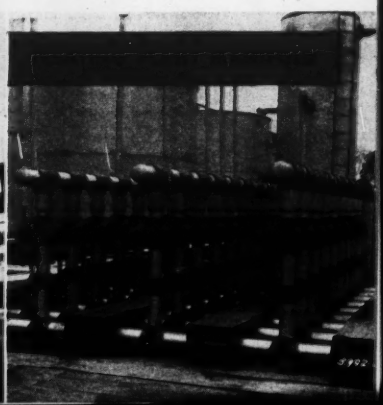
Get the Nordstrom habit. Every time you make a valve replacement, install a Nordstrom. You thereby gradually build up the standards of valve quality in your plant.

Take a manifold, for example. It may have a dozen or so old valves, some of which are giving you trouble. Requisition a Nordstrom for each replacement. Eventually the entire manifold will be 100% Nordstrom—completely modernized, trouble-free, leak-free, equipped to save operator's time—and, with Hypermatic, *automatically lubricated.*

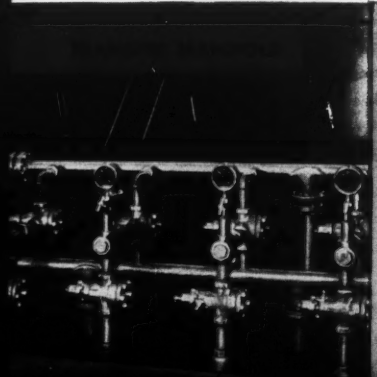
Try this money-saving habit. Step up plant efficiency. Keep upkeep down with Nordstroms.







Adopt a progressive program of replacing obsolete valves with Nordstroms



Nordstrom Valves

AUTOMATICALLY LUBRICATED

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A STEEL STOP VALVE on which YOU CAN STANDARDIZE

DELIVERIES FROM STOCK

It's no longer necessary to buy a different type of forged steel stop valve for every different service. Here's a valve on which you can standardize . . . one that fits 90 per cent of normal services where forged steel stop valves are used.

Built in globe and angle designs, from ¼ in. to 2 in. sizes, with screwed or socket welding ends. Deliveries can ordinarily be made from factory stocks.

Fig. 2698 —Globe, inside screw, 600 lb sp.

Fig. 2699 -Angle, inside screw, 600 lb sp.

Similar design, O.S. & Y. type, also carried in stock.

For design and dimensional details on these and other Edward steel valves, write for Catalog No. 104.

These Features Save you Money!

1. Low Pressure Drop — You can use smaller pipe sizes.
2. EValloy Stainless Steel Seats and Disks Borized in Mated Pairs.
3. EValized Bonnet—Wear Resistant Threads.
4. Centerless Ground Stem—Long packing life.
5. Easy Packing Adjustment.
6. Oversize Handwheel—Easy Operation.
7. Forged Steel Bodies and Bonnets.

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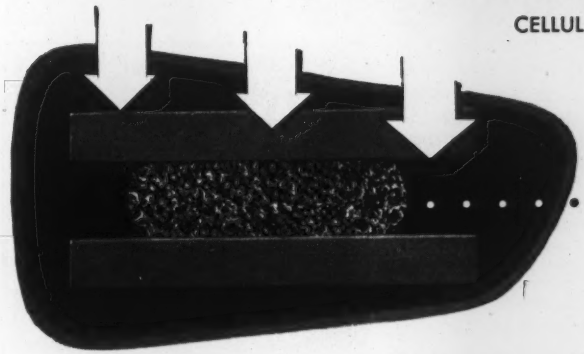
EAST CHICAGO, INDIANA

Less than 10% height loss

in SPONGEX®

CELLULAR RUBBER



. . . . . AFTER

500,000

COMPRESSIONS

Spongex performance is double A.S.T.M. flex test requirements

A standard A.S.T.M. flex test for cellular rubber compresses a piece to 50% of its height. After 250,000 compressions the loss in height should be less than 10%. Spongex meets this test in all open cell stocks. It usually tests less than 5% loss. Even 500,000 flexes result in less than 10% height loss.

This all adds up to extra performance from Spongex cellular rubber. For example, in damping vibrations Spongex can be compressed millions of times without impairment of its structure or its functioning.

Extra performance from materials and people will be more vital than ever in the days ahead. You are sure to get cellular rubber that gives extra performance when you specify Spongex.

Spongex is widely used for
shock and vibration absorption
sound damping
cushioning
insulating—weatherstripping
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Technical Bulletin on Sponge Rubber available upon request.

THE SPONGE RUBBER PRODUCTS COMPANY
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SAVE THROUGH EXTRUSION

RAPID AND ECONOMICAL PRODUCTION OF AN ALMOST UNLIMITED DIVERSITY OF STRUCTURAL AND ORNAMENTAL SHAPES OF LIGHT METALS FOR THE BUILDING, FURNITURE, AUTOMOTIVE AND AIRCRAFT INDUSTRIES.

A HYDROPRESS Development of a versatile machine of simple design, high output and easy operation, designed for minimum operating personnel and small floor space.

No longer is it necessary to store large quantities of extruded stock since with a quick change of dies any shape can be produced in sufficient quantity to satisfy immediate requirements.

BUILT IN CAPACITIES FROM 500 TO 2,000 TON

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FAST WORKING
LABOR SAVING
LOEWY EXTRUSION PRESSES
★
OIL-HYDRAULIC
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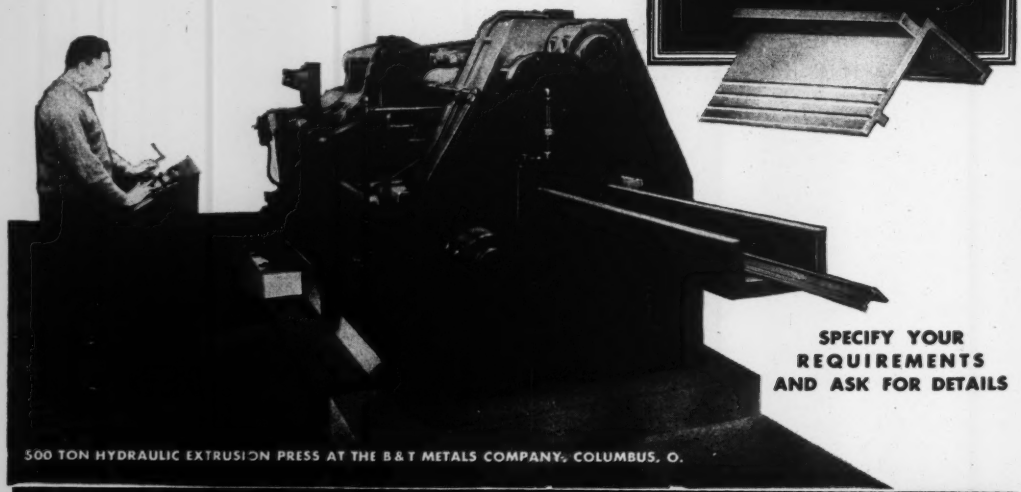

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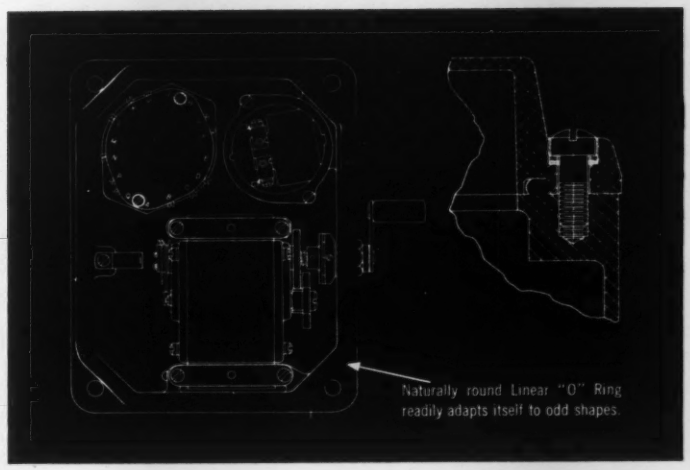

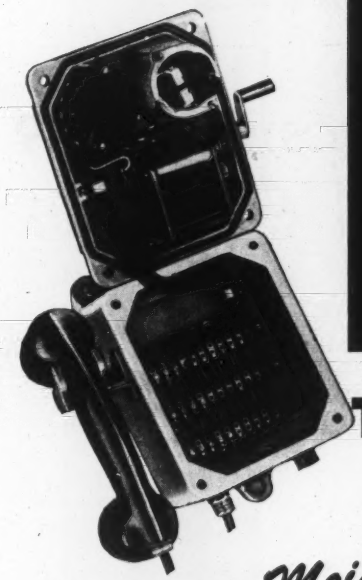

TIP... FOR THE DESIGNER

Provides a Moisture-Proof Seal for Irregular Openings with . . .

LINEAR PRECISION MOULDED "O" RINGS

The United States Instrument Corporation has licked a tricky sealing problem encountered in providing Moisture and Vapor-Proof construction for its Sound Powered Telephone Stations.

The simplified design of the cast aluminum housing produced a cover opening which might seem to require a special seal. But the versatility of LINEAR "O" Rings made the job an easy one . . . for they are readily adapted to a great variety of irregular or out-of-round shapes. In this particular case, LINEAR "O" Rings afford a highly satisfactory and economical means of assuring the proper seal . . . without requiring more than hand tightening of the four cover bolts and, the housings are tested for leakage by being submerged under three feet of water.

LINEAR "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and silastics . . . are available in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes for special uses.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

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If you are concerned with the problem of economic power supply for industrial plants it will pay you to have the

REPORT ON OIL AND GAS ENGINE POWER COSTS FOR 1949

For more than twenty years the annual issues of this Report have been supplying reliable performance and production data on oil-engine generating plants. An expansion of the scope of the 1949 Report now brings you similar statistics on dual-fuel and gas engines.

Specifically this latest Report gives cost data obtained from 102 oil-generating plants, 16 plants with a total of 37 dual-fuel engines, and 4 plants having 10 gas engines. The information is presented in three comprehensive tables with the first showing items affecting production cost; the second giving comparative costs for plants which have submitted statistics for two or more successive years; and the third providing engine details and operating information. Charts show the lubricating-oil economies of 92 plants generating 95 per cent or more of their output by means of full-Diesel units in which the kwhr output per gallon is plotted against running-plant-capacity factor; and the fuel-oil economies of 91 full-Diesel plants in which the gross kwhr output per gallon is likewise plotted against the running-plant-capacity factor.

For executives, engineers, and others interested in the economic use of power supply this Report has a four-fold value:

Data have been assembled by an ASME fact finding committee from reliable sources. . . . The information cannot be found elsewhere under one cover. . . . It is a dependable guide to operating efficiency. . . . It gives an excellent picture of true average cost. In the 1949 Report costs are presented for 25 plants making their nineteenth consecutive report, 37 reporting for their fifteenth or eighteenth year, and 32 giving data for 10 or more years.

A STUDY of these data may suggest ways and means of reducing costs in your plant. Isn't that possibility worth an investment of $2.50 ($2.00 to ASME members)—the price of the Report.

WHAT THIS REPORT GIVES YOU

Unbiased, reliable information on: Character of plant; type of load; number of engines; plant hours operated; gross and net output kwhr; percentage of gross kwhr for plant purposes; cost of fuel-oil, lubricating-oil, attendance and superintendence, engine, and other plant repairs; comparative table of important cost and production items; year engines started to work; engine hours operated; cylinder dimensions; loading; engine rating; output per unit of fuel and lubricating oil consumed; engine parts renewed; cost of engine repairs; number and duration of breakdown, personnel required.

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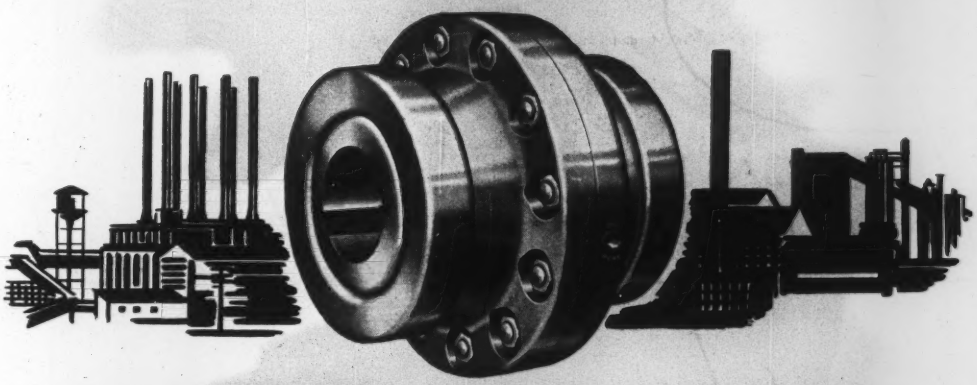

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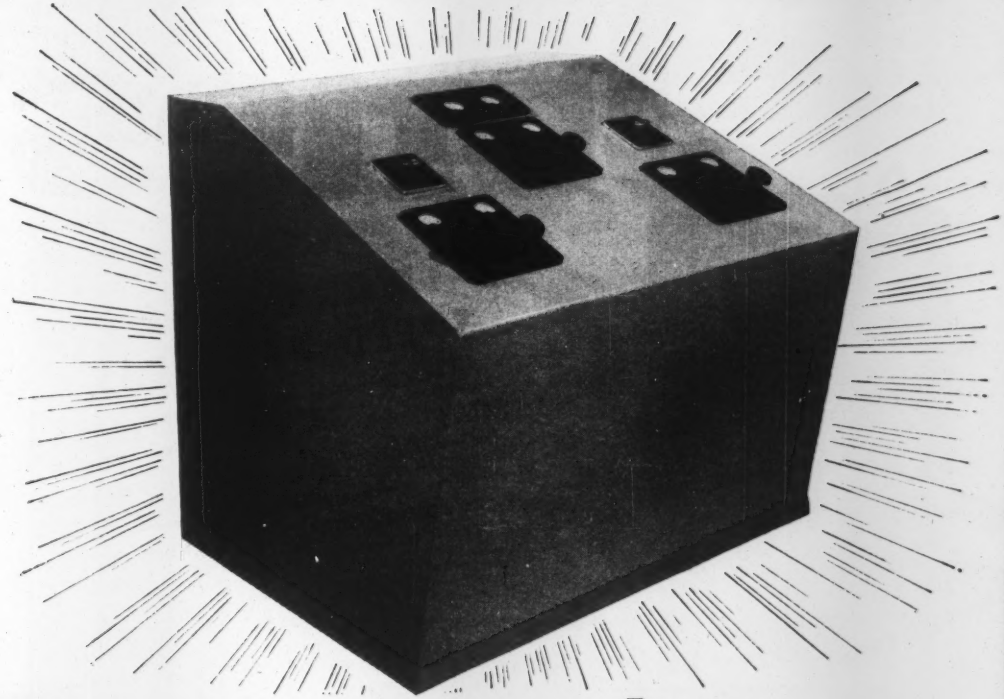

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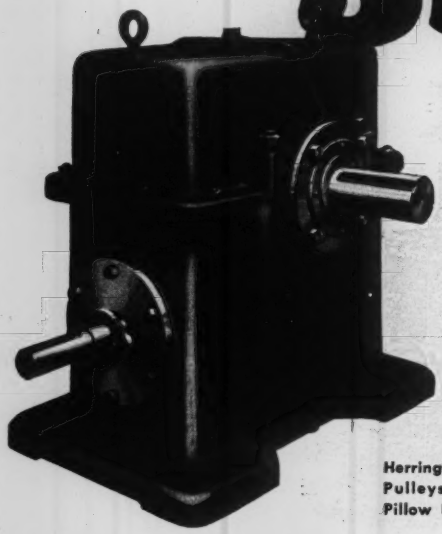

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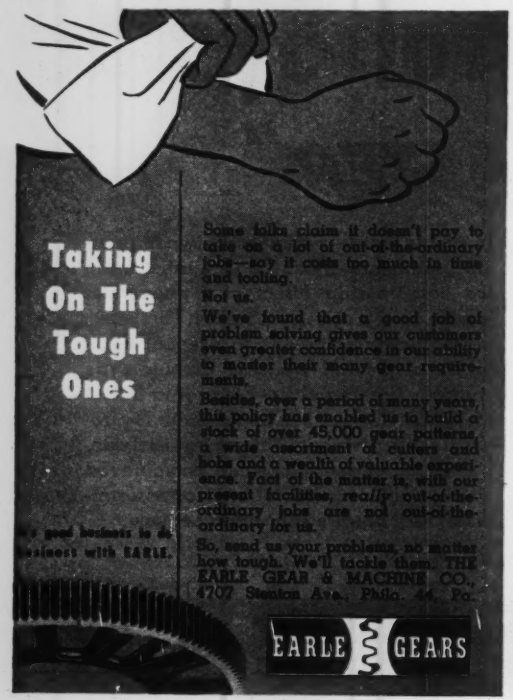

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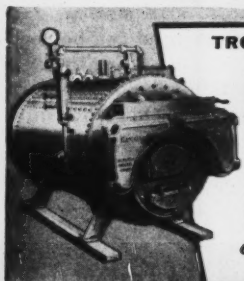

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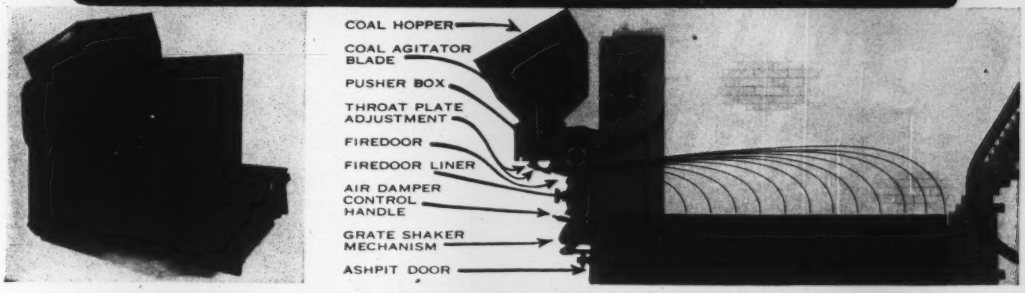

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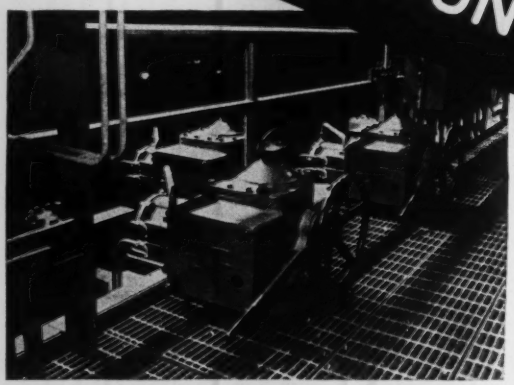

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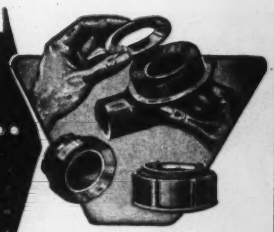

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★

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Four Pages of "OPPORTUNITIES" This Month . . . 101-104

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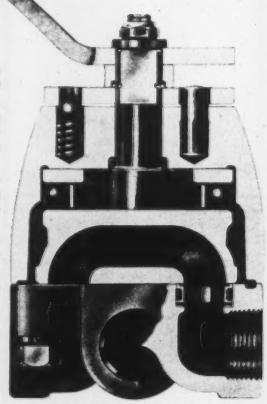

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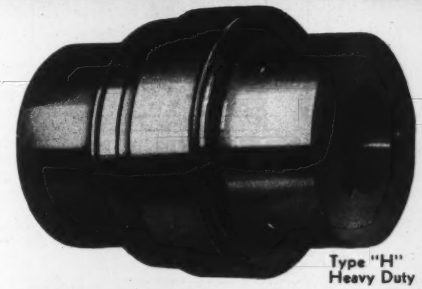

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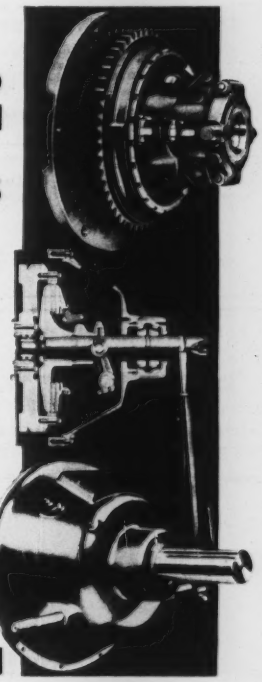

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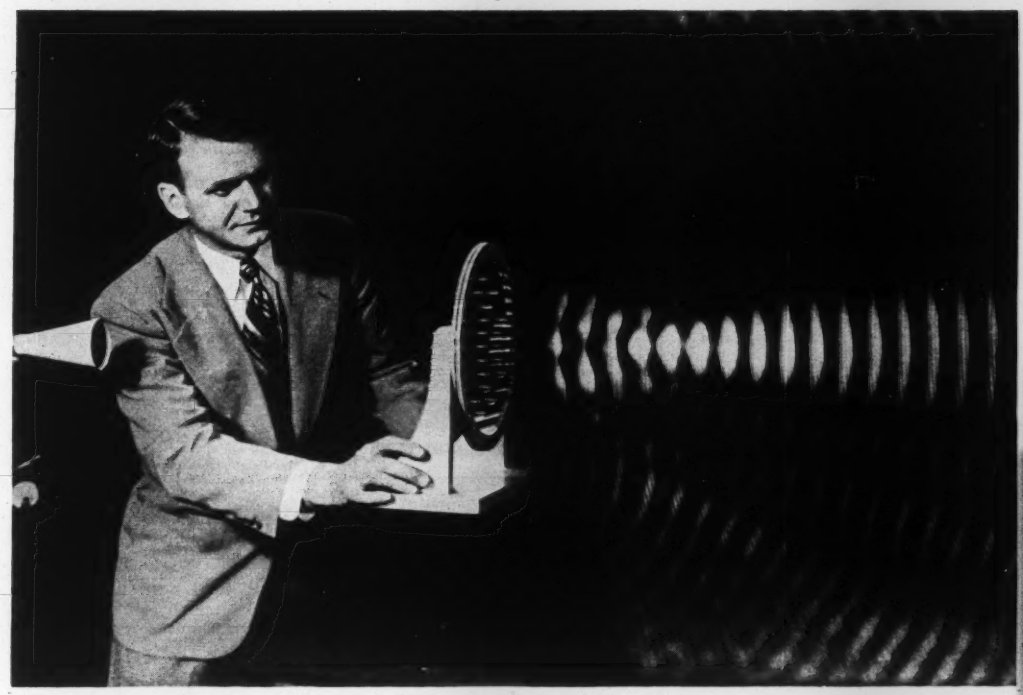

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–for better telephone service

Waves from the sound source at left are focused by the lens at center. In front of the lens, a moving arm (not shown) scans the wave field with a tiny microphone and neon lamp. The microphone picks up sound energy and sends it through amplifiers to the lamp. The lamp glows brightly where sound level is high, dims where it is low. This new technique pictures accurately the focusing effect of the lens. Similar lenses efficiently focus microwaves in radio relay transmission.

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Kendall, George H.
Lancaster, Allwine & Rommel
MB Design Consultants (Inc.)
Mast Development Co.
Myers & Addington
National Weld Testing Bureau
Nuclear Development Assoc.
Philadelphia Testing Labs.
Polachek, Z. H.
Sanderson & Porter
Sargent & Lundy
Sirrine, J. E., Co.
Stanley Engineering Co.
Tour, Sam & Co.

MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

Additional information is requested on the following advertisements in the February 1951 issue.

Page No. *Name of Advertiser*

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Name_____ Title_____

Company_____

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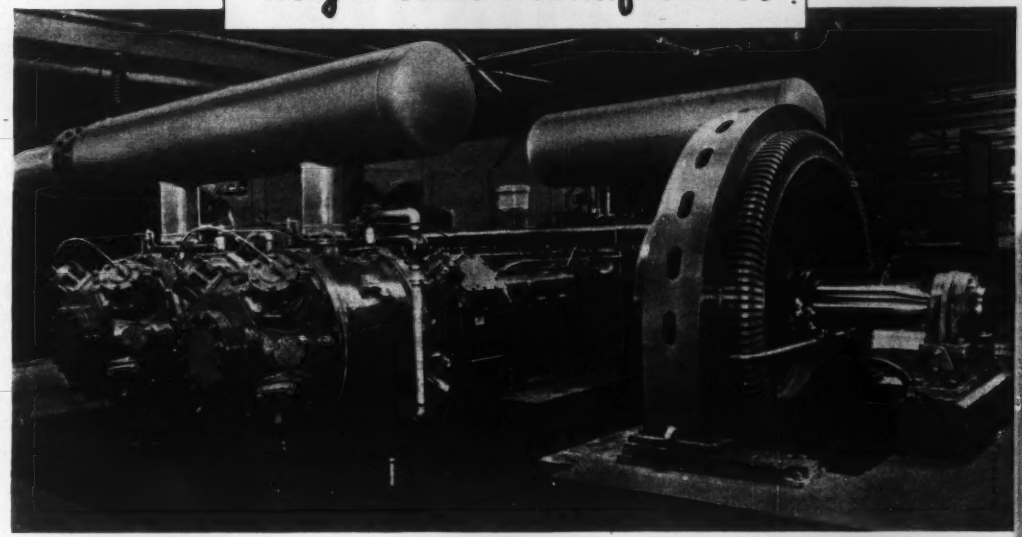
Reader Service Coupon For More Information

Go through the advertising pages and jot down the page numbers and names of advertisers about whose product you want additional information — mail the coupon to us — your request will be passed on to the advertiser promptly — you will hear directly from advertiser — saves your time in writing individual letters.

the compressor that's saving space and manpower in supplying plant air for a

Major Auto Manufacturer



Clark CBA-4 Balanced-Opposed, Motor-Driven Air Compressor. 1500 BHP. 8400 CFM. Discharge pressure 100 psig. Location: Michigan.

One compressor that does the job of several . . . compactness that's economical of space . . . vibration-free operation that simplifies foundation requirements . . . these are the decisive points that prompted a major auto manufacturer to replace many smaller units with one Clark Balanced/Opposed, Motor-Driven Air Compressor. And now, as proof of performance, two additional units will soon be delivered to effect further economies for this famed builder of quality cars.

But, being so well suited to the compressed air requirements of the automotive industry is only a partial measurement of the Clark motor-driven unit's service to other fields. Petroleum, chemical and other industries are equally strong for the space-conserving, cost-conserving aspects of this Clark-pioneered, design . . . the only balanced-opposed, motor-driven compressor manufactured in three stroke sizes covering a range of 150-4500 BHP.

Obtain full data from your nearest Clark representative. Illustrated catalog dispatched promptly.

SEE the difference in

CLARK®

balanced/opposed

MOTOR-DRIVEN COMPRESSORS

MIDGET ANGLE • RIGHT ANGLE • BIG ANGLE
ELECTRIC-DRIVEN • CENTRIFUGAL

CLARK BROS. CO., INC.
OLEAN, N. Y.

One Of The Dresser Industries

New York • Tulsa • Houston • Chicago • Boston • Washington • Los Angeles • Birmingham • Detroit • Salt Lake City • San Francisco
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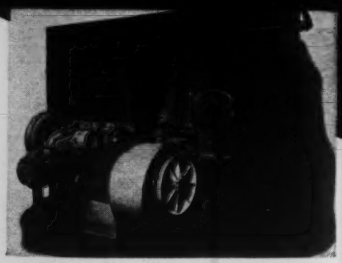
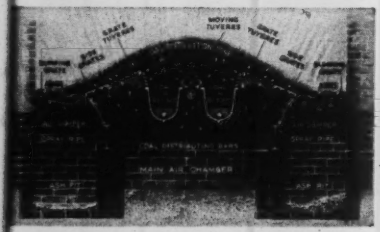
use

DETROIT STOKERS



DETROIT UNISTOKER Single retort underfeed with Adjustable Coal Feed Control.



DETROIT DOUBLE RETORT A multiple retort—side cleaning underfeed for medium sized boilers. No basement required for ash removal.

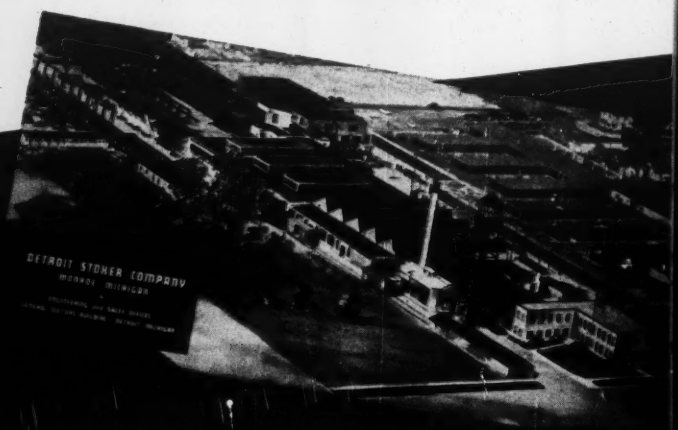
We build stokers adaptable to any type or make of boiler or steam generator. No matter what you are considering we can furnish the ideal stoker—the one that fits the furnace and is best suited to your operating conditions.

Detroit Stokers are successfully operating in thousands of boilers of different types, from firebox heating boilers to large steam generators of over 300,000 pounds of steam per hour, capacity. They are installed in private and public institutions, buildings, industrial and power plants, here and Abroad.

Assembled and Inspected In Our Plant Before Shipment

Each stoker that we design and build is assembled by experts in our plant and carefully inspected prior to shipment. You can't go wrong with Detroit.

Built to outlast the boilers that they serve, Detroit Stokers give you the best, most economical firing method for your needs. An informal discussion with one of our Engineers will cost you nothing and might save you a lot. May we hear from you?

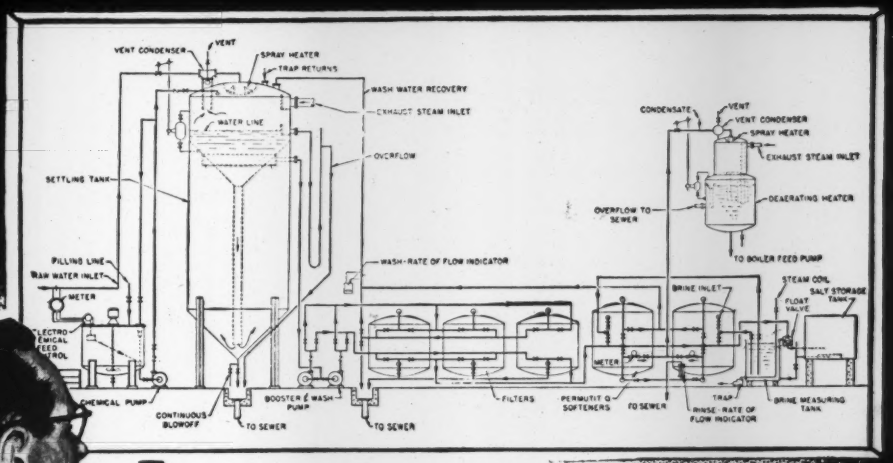


DETROIT STOKER COMPANY

DETROIT STOKERS

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

District Offices in Principal Cities . . . Works at Monroe, Michigan



"...have you heard about Permutit's New Hot Zeolite Process?

"Permutit announced the process only a few months ago, but already we're putting it to good use in our plant. We think it's the best way of producing water that's low in alkalinity and silica . . . and with all hardness removed."

"Say, Ed, that's really something . . . getting an effluent of zero hardness from a hot lime soda softener! How's it possible?"

"Well, you see, Joe, they've developed a new mineral, Permutit Q. It's an ion exchanger that will withstand boiling water with a pH over 10, and it's not affected under operating conditions like that even after 1300 regeneration cycles."

"Tell me more! Is Permutit Q more economical than phosphate?"

"It is, and what's more, it reduces CO_2 in the steam. I'm really sold on this new process, because our chemical costs are lower, our effluent is lower in alkalinity and total solids, and we don't need acid feeding to prevent deposits in our high stage heaters and economizers."

"The more you tell me, Ed, the more I want to know. I think we could put this new hot zeolite process to work in our plant, too. How can I find out full information about it?"

"If you write to Permutit, they'll send you a new bulletin *full* of information. I have their address somewhere . . . oh yes! It's The Permutit Company, Dept. ME2, 330 West 42nd Street, New York 18, N. Y. Then there's the Permutit Company of Canada, Ltd. at 6975 Jeanne Mance Street, Montreal."

"Thanks for the tip, Ed. I'm sending them a letter today!

Water Conditioning Headquarters for Over 37 Years

PERMUTIT

How TIMKEN® bearings help cut gear shaving time in half

THIS new Red Ring Diagonal Gear Shaver finishes gears to amazing limits of accuracy in less than half the time it used to take. It is built by the National Broach and Machine Company, and is mounted on Timken® tapered roller bearings to insure maximum cutting precision and long, trouble-free service. Timken bearings are used in the tail stock and headstock on the intermediate and vertical drive shafts, and on the cutter spindle.

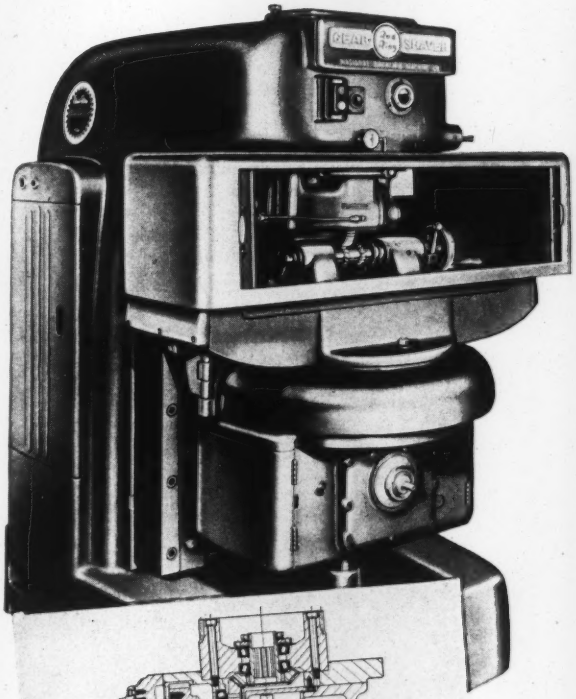
Fast, accurate gear finishing with minimum time out for maintenance is assured because Timken bearings keep shafts in rigid alignment, yet allowing them to rotate with negligible friction. Deflection and end-movement are minimized.

Line contact between the rollers and races gives Timken bearings extra load-carrying capacity. And because of their tapered construction they can take any combination of radial and thrust loads. Pre-loading is permitted to any practical degree.

Timken bearings are built for long, tough service. They're made of special analysis Timken fine alloy steel and are manufactured to extreme precision. Finished to incredible smoothness, Timken bearings virtually eliminate friction. And bearing surfaces are case-hardened for exceptional resistance to wear, and have tough, shock-resisting inner-cores.

Remember, no other bearing can give you *all* the advantages you get with Timken tapered roller bearings. Whether you build machine tools or buy them, always be sure they're Timken bearing equipped. Look for the trademark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



This is how the **NATIONAL BROACH AND MACHINE COMPANY** *uses Timken bearings in the cutter gear case of its Red Ring Gear Shaver. Greater accuracy, higher cutting speeds, trouble-free performance are assured.*

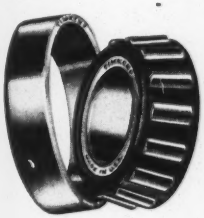
NEW ENGINEERING JOURNAL OFFERED!

529 PAGES! Includes new, technical information on bearing applications available nowhere else. Especially helpful to design engineers. Gives bearing dimensions, capacities, selection and mounting data. For a copy, write on your company letterhead to The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓡ AND THRUST →ⓣ← LOADS OR ANY COMBINATION →✳←